ELECTRICAL ENGINEERING

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STRONG AS SAMPSON BUT LICKED BY A RAINDROP

Strength in line hardware is merely a matter of putting enough metal in the right place. But, then, time comes into the picture. "Enough metal" may not be there after a few years' corrosion has done its work... There is one sure way to keep all the metal you originally bought. Buy O-B malleable iron! The long-lived, galvanized coating is re-ënforced by an inherent property of this metal... A characteristic of malleable iron is the formation of an almost indestructable coating of iron-oxide that sticks tightly to the base metal. Unlike certain other ferrous metals, this coating will not erode away to expose fresh surfaces underneath. One coating of rust, and the metal is then protected permanently by Nature... O-B hardware doesn't "wash away" over a period of time. Corrosion doesn't alter design; doesn't reduce vital dimensions. Years later, you still have all you originally bought... That's one reason why O-B uses malleable iron for line hardware. That's why you should cash in on O-B's experience in both material and design.

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FEBRUARY

1943

The Cover: An M-4 tank in action. Electricity performs essential control and communication functions in these mighty "battleships of the land." Official OWI Photo by Palmer

TRANSACTIONS SECTION

(Follows EE page 86; a preprint of pages 53–106 of the 1943 volume)

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HIGH LIGHTS • •

Equivalent Circuit. A practical equivalent circuit for a five-winding transformer is presented, together with a development of the necessary formulas. Examples show how the various equivalent-circuit parameters are evaluated, and factors affecting the voltage regulation of the transformer are brought out with the aid of an example in which two sources of supply are present (*Transactions pages 66–70*).

Emergency Loading of Transformers. By locating portable capacitor units at strategic points on a power system, permissible loading of closed-delta transformer banks may approach the safe thermal limit and still be operated in open delta in emergency. The mobility, light weight, and simplicity of connection permit rapid installation of the portable capacitor units (*Transactions pages 83–6*).

Letters to the Editor. Among subjects discussed in the "Letters to the Editor" columns of this issue are regulation and load division in a three-phase, four-wire network (*pages 84–5*); terminal corrections for temperature tests on short conductors (*pages 83–4*); capacitance and dissipation-factor correction (*pages 85–6*); and static electricity in gasoline fires (*page 83*).

Electromechanical Calculator. An electromechanical calculator, designed for the rapid solution of directional-antenna patterns, draws the field-intensity curve automatically to any desired scale on a sheet of polar co-ordinate paper and indicates the rms value for drawing a circle of the equivalent nondirectional pattern (*Transactions pages 78–83*).

Switching Overvoltage Hazard. Suitable resistors, interposed across the interrupting elements during the opening stroke of a high-voltage oil circuit breaker, may either eliminate the switching overvoltages by preventing restriking, or reduce them in magnitude in the event of restriking so that the transmission system is relieved of their hazard (*Transactions pages 98–106*).

Linear Conductors of Structural Shape. Many busses for heavy-current duty now are being constructed of linear conductors of structural shape because of their many mechanical and electrical advantages. Formulas are derived in a paper in this issue for the inductance of busses composed of such conductors (*Transactions pages 53–8*).

Stability Study. An analysis to determine basic performance data of series-capacitor-compensated long-distance transmission lines under steady-state and transient conditions partly answers the question of where reactance compensation is applicable, and also permits certain general conclusions to be drawn (*Transactions pages 58–65*).

Equivalent Ambient Temperatures. Monthly equivalent ambient temperatures, obtained through calculations based on weather-bureau records, can be used in combination with load curves for determining the permissible safe overload for a transformer in a given locality (*Transactions pages 87–93*).

Wood-Pole 230-Kv Line. Problems encountered in the construction of a 230-kv transmission line with wood-pole structures include the stresses involved, foundation requirements, and dimensions of structural members necessary to maintain separations between conductors and ground clearances (*Transactions pages 94–7*).

Distribution-Factor Error. A method is presented of correcting a common error often made in the use of the distribution factor of electric machines when a winding consists of a fractional number of coils in series. The method also assists in determining the best distribution of such a winding (*pages 68–72*).

British Engineering Corps. The recent formation of the Royal Electrical and Mechanical Engineers is expected to bring electrical and mechanical engineering maintenance in the British Army under single control. The organization and function of this new unit are described in this issue (*pages 80–1*).

Paired-Phase Bus Bars. A new paired-phase method of arranging bus bars is said to have excellent temperature rise, voltage drop, energy loss, and structural characteristics for polyphase currents in the range of 1,000 amperes and above at 600 volts and less (*Transactions pages 71–7*).

Wartime England. How industries, utilities, and civilians in England have rallied to meet the exigencies of air attack is told in this article, which points out how various phases of life in England have been keyed to war conditions (*pages 55–60*).

Pasteurization. Some up-to-date information on electric pasteurization is presented in this article along with a brief history of the process. Temperature control, vital factor in pasteurizing, is discussed in some detail (*pages 60–3*).

Airport Lighting. Wartime and black-out regulations have made it necessary to reduce airport lighting. Methods for operating airport lights in accordance with these regulations are suggested in this article (*pages 64–7*).

Conservation. United States Army agencies are easing wartime production problems by using alternate materials in a variety of war supplies and implements (*pages 53–4*).

Coming Soon. Among the special articles and technical papers currently in preparation for early publication in *Electrical Engineering* are: a discussion of recent developments in organic plastics for electrical insulation by Thomas Hazen; an article on research in the war effort by Vannevar Bush (F '24); addresses delivered at the presentation of the Edison, John Fritz, and Hoover medals during the 1943 AIEE winter national technical meeting; analysis of a method for determining allowable overloads for transformers, which takes into consideration individual transformer characteristics, by L. W. Clark (M '42); a study of maximum continuous current-carrying capacity of copper conductors in overhead lines, as governed by certain operating limits of temperature and time, by A. H. Kidder (M '39) and C. B. Woodward; a description of a multiorifice interrupter for high-voltage oil circuit breakers by L. R. Ludwig (M '41) and W. M. Leeds (M '38); a discussion of the effect of radio frequencies of a power system on radio-receiving systems by C. V. Aggers (A '39), W. E. Pakala (A '38), and W. A. Stickel; an investigation of the use of synchronous motors with controlled excitation for suddenly applied loads by W. K. Boice (A '39), B. H. Caldwell (A '37), and M. N. Halberg (A '29); a discussion of kilowatts, kilovars, and system investments by J. W. Butler (M '38); a description of a method of calculating transmission losses within power systems by E. E. George (F '36); a study of preventive maintenance applying to traction motors and generators by J. W. Teker (A '31); a report of laboratory test results on permissible pulling loads, to which solid-type impregnated-paper lead-sheath power cable might be subjected, by A. P. S. Bellis (A '26), and an analysis of the effect of current-transformer residual magnetism on balanced-current or differential relays by H. T. Seeley (A '27).

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Wartime Material Conservation and Production Problems

W. H. HARRISON
FELLOW AIEE

An AIEE past president, now brigadier general in the United States Army, tells how certain branches of the Army, sacrificing critical materials needed for their own supplies, are effecting conservation and easing production problems through the use of substitutes. Pointing out that in the fields of conservation and substitution engineers can be of greatest value in expediting the war, he urges engineering societies to co-operate in this work.

I HAVE had the good fortune to see war production develop from the planning and speculation stage to the point where, in so far as the Services of Supply of the United States Army are concerned, current monthly production is reasonably well up to expectation, though still short of needs. Yet it is far beyond anything the most imaginative of men could have anticipated, and far beyond anything attained by the United States or any other nation through any period of its existence.

Born of 30 odd years' experience in a business wholly dependent upon forward-looking planning—advanced and sound use of pure science and applied engineering—I can say without reservation that American industry and American government, teamed up as they have been ever since war production started, have done and are doing the impossible. In making this observation, I am not unmindful of things done that should not have been done, and of things not done that clearly should have been done.

By way of explanation, I cite the history of one of the departments of the Services of Supply as contrasted with the history of three outstanding American manufacturers. During its period of growth the United States Steel Corporation (1902 to the present) has increased 3 fold; the General Motors Corporation (1918 to the present), 8 fold; the General Electric Company (1899 to the present), 30 fold; and the Ordnance Department of the United States Army (1940 to the present), 700 fold.

The reason for success in this astronomical increase is to be found in the years of sound, imaginative planning by the procurement agencies of the different services, and great credit is due to those who had the vision.

In its evolution a program of this magnitude passes through three principal phases, and at any given time the emphasis is on one of the three: in historical order, first, creation of the facilities and placement of orders; second, flow of material; and third, men and women organized and trained to do the work.

Of course, underlying and running through the entire program every day of its existence, there is broad planning and detailed co-ordination and integration, there is continued and intensive research and engineering. And there is the most exacting demand of war, second only to time itself, that is change which, incidentally, by violent contrast is the most destructive force to mass production.

The influence of change not only is felt in revisions of design and specifications to bring maximum fire power to bear on the enemy, but also, and equally important, it is felt in basic revisions of the type of combat units themselves, which is dependent in turn on the particular type warfare which must be carried on. A foot soldier in the jungles of the Pacific Southwest certainly requires different type support than one on the sands of the Mediterranean.

PRODUCTION PROBLEMS

Considering production requirements for a complement of foot soldiers as a unit of one, a motorized complement is 2, and an armored-tank complement is 5.1. From this it can be seen readily that any realignment in type of combat forces has an immediate and substantial influence on production requirements. I make reference to this to indicate there never should be and probably never will be any period of war manufacture without change, change in type and change in quantity.

By and large, the first stage of the program, creation of facilities and placing of orders, is in hand. This is no longer the limiting factor in output. The present limiting factor is flow of materials, not so much over-all flow, as a balanced flow of particular sizes, shapes, and metallurgical content. For example, in normal times alloy steels using nickel, chromium, vanadium, molybdenum, manganese, and silicon amounted to about 7 per cent of total steel requirements in the United States. Today that percentage is about 20.

Perhaps ingots of steel, copper, lead, and aluminum

Based upon a talk given before a joint meeting of the AIEE Washington, D. C., Section, with the local sections of the American Society of Civil Engineers and the American Society of Mechanical Engineers, December 9, 1942, at Washington, D. C.

W. H. Harrison, vice-president on leave from the American Telephone and Telegraph Company, New York, N. Y., is a brigadier general in the United States Army, serving as director of procurement, Headquarters Services of Supply.

may be within striking distance of minimum needs, but specified bars, rods, castings, forgings, and extrusions are inadequate as to absolute amount, and inadequate with respect to relationship between the various sizes, shapes, and type of material. To make an aircraft wing there must be a specified amount of sheet, tube, bar, and rod. Sheet is not much use without the other items. Similarly, steel-carbon bar and plates may be available but a tank cannot be completed unless a specified amount of alloy-bar stock is also available.

The solution of this situation rests on a combination of factors: better control of the flow of material, additional output of critical raw and semiprocessed basic materials, more substitutions, and reduced use of these critical items in other than essential cases. A good job in each of these factors is fundamental.

Brigadier General W. H. Harrison

SUBSTITUTION AND CONSERVATION

I am touching on substitution and conservation because I think this is the field in which the engineering groups can be of most help. Conservation and substitution today do not mean that original designs were faulty. A part designed to be of aluminum may be the most efficient and effective, but with the pressure for aluminum for airplanes, we cannot afford to use it on ordnance parts, consequently we shift to steel, malleable iron, or some other less critical metal.

Again, a fuse part designed to be made of brass may be the ideal, but with the pressing need of brass for more essential uses, we find ways and means to make the fuse partly of steel or iron and partly of plastic.

Turning to another field, the extreme need for shipping space concentrates attention upon every form of package or packaging, first, to save shipping space, and next, to save the material used in the package.

This intensified drive for conservation has brought about amazing results. For instance, a primer tube originally designed to be made of brass is now made of steel. With millions of such tubes to be produced, the saving of brass runs into thousands of tons. A cartridge tank, originally of aluminum, is now made of steel and it is estimated the saving of aluminum is enough to build 500 bombers. A booster adapter, originally cut out of bar stock, is now made on presses, with a saving of thousands of tons of steel, and countless machine tools and man-hours.

Cartridge cases have always been made of brass, high-grade brass, the ideal substance for this purpose. The requirements of a cartridge case, that it expand sufficiently at the mouth to prevent the passage of gas, that it be strong enough at the base to prevent it from expanding and sticking, and that the primer parts should have the same coefficient of expansion as the case, all point toward brass. With insufficient brass we must turn to large-scale production of steel cases in all sizes. This means intensive research, experimentation with various kinds of steel, drawing, heating, and finishing operations, then extensive field-service tests and trials.

In the efforts to accelerate the program of conservation, we are trying to avail ourselves of every particle of information obtainable from our allies and our enemies. Everything captured or received from the enemy is subjected to searching analysis, and on the whole, there is little to indicate use of inferior materials.

Every department of the Services of Supply has its special consultants, and in turn the knowledge and experience of each department and the knowledge and experience of each manufacturer in a given field is brought to bear on the others. As to be expected, most intensive work is in the field of ordnance, and here startling things have been done. Booklets, copies of which are available, tell in an intriguing way about this work. Recently the Chief of Ordnance canvassed all his contractors for suggestions. Some 1,100 were received, 60 per cent of which are being put to effective use.

THE ENGINEER'S PART

In conjunction with the War Production Board the Services of Supply are urging that engineering societies band together in common purpose to help with this fundamental job which is yet to be done. I have attended many joint meetings throughout the country and can attest to the constructive interest being taken and the fine work being done.

As a member of the engineering profession, I take modest pride and satisfaction in the part the engineers are taking in this war effort. Despite the fact that as in all wars, the brunt of this one must be carried by the men on the combat fronts and on the field-supply lines, nevertheless, this is a war of research, of engineering, and of equipment. Victory will be with us because we have the best fighting men in the world, because they are equipped with the best weapons on the field, and because banded together the citizens of these United States have determination to see this war through to their way of peace. Give the men of the United States forces and the men of allied forces more weapons at the combat fronts, and they will soon write the victory march.

England—Its Civilian Protection and Industrial and Utility Operations in Wartime

DAVIS M. DEBARD

English industries, utilities, and civilians have prepared for protection against blitz attacks, have carried on during them, and have set about to repair damages after them with courage and determination. Pointing out their splendid spirit and accomplishment under war conditions, the author of this article suggests that we in the United States might well draft our pattern for wartime living and working along lines similar to theirs.

WHEN this war is over, a story of heroism and devotion to duty will have been written about the employees of the English industries and utility companies. Many employees have been killed in their line of duty, and a great many more have been injured. When their homes were bombed during the night, the majority reported on time for work the next morning. When their families were evacuated from London and other congested areas, they remained to carry on. The trials and triumphs of British utilities as they have daily gone about their task of maintaining service to their customers in thickly populated areas and to the war industries under the constant destruction of the Nazi blitz is another story which we shall read some day with great pride. The English people, as a whole, living under a strain such as few people in the world have ever known, have gone forward with indomitable spirit, but we should all be especially proud of the devotion to duty of our fellow workers across the sea who have maintained service under the most trying conditions.

PROTECTIVE MEASURES

When the English industries and utilities found that war was inevitable, what did they do for their protection?

First, after providing additional guards, establishing the pass system of employees, fencing property, and erecting protective walls, they set about to train their employees, from office boy to president, in just what part they must play when their plant and distribution system suffered from fire and bombing. I observed in August 1939 some of these training classes at the British Gas Light and Coke Company, field laboratory, the Watson House, located on the outskirts of London. Several hundred employees were placed at windows on second, third, and fourth floors of adjacent buildings while actual bombing in an open field was carried out on gas mains, which, after the explosions, set fires in a number of dummy houses. Valves were turned to shut off gas, and different methods of fire fighting were demonstrated, and repairs were started. This was to give the employees a first-hand picture of actual bombing conditions. It is very important to train the eye to observe the damage, the ear to get accustomed to the horrible sounds, and the mind to record plans for action. These demonstrations were carried on for many months and some 16,000 employees in one large company knew exactly the parts they were to play under actual bombing.

Second, various types of camouflage were used to make plants more difficult to spot from the air. This was worked out in conjunction with the British Air Force, which made observations at various levels. A new smoke and fog camouflage has been developed that will blot out a blast furnace, an electric plant, or gas plant, from the air pilot's vision within a few minutes' time after the first flash of air-raid signal. All local city smoke abetment ordinances have been rescinded in England for the duration.

Black-outs, which from the outbreak of war have been complete black-outs—all night, every night, every place—are enforced in homes, stores, factories, and power stations by total screening of windows, skylights, doors, and other apertures against the egress of light from within. Full inside illumination is encouraged. Darkness inside buildings, in addition to being very bad for morale, would hold up production.

Third, electric distribution systems were sectionalized, with a number of connections to main source, and all isolated generating plants in the area were required to be interconnected with the central station system in order to furnish current for hospitals and other emergencies. Gas distribution systems were interconnected with other gas companies wherever feasible. Utility interconnections so widely used in America have proved of great value in maintaining service during the war in England.

The following data were received from the manager of the Metropolitan Water Board of London, which supplies water to approximately nine million persons in an area of 537 square miles. The system has over 8,000 miles of mains supplying 300,000,000 to 400,000,000 gallons of water per day to its users. The source of its supply

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This article presents the essential substance of an address delivered at a meeting of the AIEE Philadelphia Section on November 9, 1942.

Davis M. DeBard is vice-president of Stone and Webster Service Corporation, New York, N. Y.

is two thirds from the Thames River, one sixth from the River Lee, and one sixth from hundreds of deep wells. Over 80 per cent of the water used is derived from polluted rivers. Mains under 12 inches are called small and those above, large. Large mains are usually fed from both ends.

Reservoir filtration plants, pumping plants, and distribution systems are divided into 20 separate areas. The operations of all areas are controlled from a central operating point. The usual method in prewar days was:

1. Storing in reservoirs.
2. Filtration through sand filters.
3. Chlorination.

Because of war conditions and the great demand upon the water system for fire fighting and drinking purposes, another precaution has been added, that of prechlorination.

What has been the effect of bombing on this system? The fracture of water and sewer mains by high-explosive bombs constitutes the greatest danger—pollution of drinking water—that the water companies have been called upon to face. Polluted water can be more dangerous than bombs or bullets. To date, because of the efficient operation of the water and sewer departments of this great London metropolitan system, practically no typhoid has resulted from breaks caused by bombing. Bombs of 500 pounds when striking a concrete street will crack cast-iron pipe to a distance of some 50 feet from the point of contact. It seems to flatten and break steel pipe at the joint, but London has comparatively little steel pipe.

Experience has shown that in most every raid there are one or two breaks, and it has also shown that in raids of two hours, or more, a number of so-called large water-main-pipe breaks always have occurred. Literally during the past two years in London hundreds of breaks have occurred where sewage and drinking water pipes have been broken at the same time. For example there was an instance in which a crater was filled with a mixture of sewage and water. The main, which fell away downhill from each side of the crater, was isolated by valves about a quarter of a mile distant on one side and three quarters of a mile on the other.

The main was shut off and it was found that the crater rapidly filled with sewage. This was kept down by pumping during the day, but at night pumping was not permitted and the trench filled with sewage, which poured into both ends of the water main. When the repair was nearing completion, one leg of the main was emptied through an emptying valve and the other leg was drilled for a corporation cock immediately in front of the charging valve. This leg of the main emptied itself through the hole made. When the repair had been completed, chlorination was started and a good dose put in before the charging valve was opened. The administration of chlorine was continued until its presence could be demonstrated at the bottom of the opposite leg and the main was fully charged with chlorinated water.

As this was a case of pollution in extreme degree and the main was known to contain large quantities of particulate matter, the usually short contact time was extended to several hours. A sample drawn after the main went back into supply gave the following result: bacteria coli in 100 milliliters, nil.

Large mains, and particularly trunk mains, present a very different problem; sewers broken by the same bomb may be wholly or partially obstructed, and widespread flooding with polluted sewage may occur; valves are present only at considerable intervals, and the volume of water to be treated with a heavy dose of chlorine demands a larger quantity than could be conveniently handled as a powder or solution. It was decided that the injection of a solution of chlorine derived from cylinders of liquid gas would be the only practicable method for applying the desired treatment, despite the possible risk of cylinders of chlorine in the streets. Consultation with the suppliers of liquid chlorine indicated that the risk of serious escape of gas would be small and would be unlikely to result from any cause other than a direct hit by a bomb. Cylinders should not be left in the streets at night.

Comparatively little damage has been done to the pumping plants and filter beds.

What methods were put into effect for the protection of property and the supply of water? After buildings have been damaged, where it is at all possible, the basement is cleared and sealed and filled with a supply of water as an emergency system. Many swimming pools and a great many cisterns have been so constructed. Each individual is supposed to keep on hand at least three-days' supply of bottled drinking water, and there has been provided for each district a number of 500-gallon water tanks which can be rolled upon trucks quickly, taken to prescribed places, and filled (not from hydrants on account of the danger of pollution). Deliveries are then made to the householders at the rate of about one gallon per person per day. Loud speakers attached to trucks are used to drive through the streets and warn the people of any pollution that might be in the water. They are instructed to boil the water.

The main precaution is that of prechlorination, which has added a fourth line of defense to the three that previously existed; namely, storage, filtration, and terminal chlorination. Chlorination instruments and pumps have all been protected against damage, many of them by the construction of specially designed bombproof buildings.

Each district has been provided with chlorine gas tanks fitted on trailers. These can be brought quickly to any broken main. The automobile could then return for an additional trailer if found necessary. The water departments were quite skeptical about these gas trailers, but little trouble has been experienced with

them from other than a direct hit. The British Government has been quite strict in keeping any of the towns from discharging any treated seepage into the Thames or Lee Rivers. This is to keep the pollution as low as possible, so that when excessive amounts of water are needed to fight fires, filtering and prechlorination will keep the water from being contaminated.

Essential repair parts are kept in all districts in bomb-proof shelters, and six-ton portable tractor-type cranes have proved invaluable. Before the war the Metropolitan Water Board purchased some 350 bicycles for use in air raids. These are used continuously by messengers, firemen, and others. The work could not have been carried out successfully without them. An organized emergency service, constant guarding of all reservoirs, testing of water at different locations, and experienced repair crews have all proved their value. Too much cannot be said for the loyalty and self-sacrifice of the chlorine and laboratory staff, who have worked through long hours of air raids, frequently during the night under long bombardments, together with repair crews, pumping crews, and the entire staff of the water works, for their valor under fire and for their superb protection of both health and water supply, that London should never burn nor its people be affected by disease.

Top water levels in certain large reservoirs have been lowered as an emergency measure in order to reduce the risk of flood and consequent damage to adjacent life and property in cases of bombed outlet.

A single pump may run long hours totally without any other connection except that between different tank mains, and this can offset to a large extent the effect of any single break. But the cumulative effect of fractured mains and possible heavy demands for fire fighting can reduce pressure in the mains to zero or cut off the supply entirely. Failure of water pressure at chlorinators has been alleviated by the installation of suitable pumps used at key points.

PROTECTION OF PROPERTY

In order that production may not be delayed unduly, in cases of bomb damage, most electric and gas utilities and industries also, have a supply of essential spare parts for their machines stored in bomb proof shelters. After two years of bombing, it is reported that repairs have been made with such speed that comparatively few electric and gas customers are without service within a 24-hour period.

Sand is kept available in buckets and in half-filled bags to extinguish fire bombs, and there is the stirrup pump, which, when used in conjunction with a bucket of water and hand operated, throws a small swift stream of water.

Although bombs have pierced many gas holders, causing loss of gas, they have not caused explosions. Some holders have caught fire, but fires were extinguished speedily. Holders can be repaired quickly. One has had 256 patches, and has been put in operation again.

Telephonic communication is extremely vulnerable to air attack. Many companies have strengthened their communication systems by using two-way radio, additional direct emergency telephone service, and, other types failing, an organized messenger service. This messenger service has proved its value many times. Radiobroadcasting stations are not used for air-raid alarms or precautionary instructions. The band just plays on. People might be excited and panics might be caused. Courage and keeping one's head are vital during fires and bombing raids. Calmness and forethought are just as vital to civilian defense, as black-outs or air-raid shelters, and they cost nothing. A series of light signals are given to industries before sirens sound. Roof spotters sound local horn or loud-speaker when air raiders are approaching the plant. Employees are used in shifts during the night for fire spotting. From all accounts, very few electric and gas plants have been put out of commission. The damage done by bombs has been speedily repaired.

In the great bombing of Coventry, the gas works was hit four times but never ceased production. Service was restored in some cases by laying pipes on top of the ground a short time after the all-clear signal sounded. The manager of the Coventry gas plant jokingly said that with just a few more well-placed bombs, he would have a much-needed new plant.

The following is a quotation from a recent English letter:

> Steel buildings stand up well. The brickwork panels get blown in or sucked out; doors, windows, floors, and roofs get displaced; but the main framework is seldom damaged. Brickwork supporting heavy weights is particularly dangerous. One side gets blown in by blast and the whole structure collapses. Under blast, tiles and slates depart like chaff in the wind; hence, considerable stocks of roofing sheets of galvanized steel or cement asbestos boards, and rolls of rubberoid roofing material are useful to have on hand under blitz conditions.

Bombs of from 100 to 500 pounds will make craters in the streets from five to ten feet in depth. Water, gas, and sewage pipes will be broken at a distance of from 30 to 50 feet from the point of direct impact. This is caused by the earth shock. After a study of utility reports on the effect of some several hundred different bombings of utility property, it is amazing the small amount of damage that was done and how speedily the repair gangs were able to restore service.

Antiaircraft shrapnel does not pierce the tops of gas holders or oil tanks, although it may injure roofs. Bombs when exploding are said to scatter into about 2,000 to 6,000 pieces. The most destructive bombs are the 2,000- to 8,000-pound land mines which float down on a parachute, exploding on earth's surface. These will level as much as four city blocks.

English buildings are made of brick largely, and many of them have been standing for hundreds of years.

These buildings have been subject particularly to lateral bomb shocks. Such buildings as have been framed with steel, similar to those commonly used in the United States, are little damaged. Records show a 500-pound delayed-action bomb which is about the size of a man, falling from 15,000 feet or more, will penetrate the roof and some five stories of a steel and concrete building having six-inch concrete floors, if it does not strike a beam or girder. Thus, one would be fairly safe during an air raid in a building more than six floors down from its roof. Steel girders seem to give and bend under bombing and only the walls and partitions are damaged.

From all reports, factory production has not been greatly harmed by the blitz. One report claimed that after the bad bombings, production had only been affected by five per cent. When factories in congested areas are damaged, they are moved to country areas and constructed in smaller units, thus lessening the risk from air. One airplane factory is reported to be in operation 90 feet underground. Parts for tanks are being made in 6,000 small factories and assembled in large factories. From all we are able to learn, production of war materials is at a very much increased rate over that of six months ago.

All important contracts and documents held by industries and utilities have been triplicated and filed in three separate areas for protection. Vaults are protection against fire and theft, but are not a protection against aerial bombs. This, in itself, must have been quite a problem.

In addition to the explosive bombs, one of the greatest problems is the magnesium fire bombs which weigh about $2^1/_4$ pounds each. One airplane can carry about 1,000 of these fire bombs. In falling from the enemy airplane at high altitudes, they are of sufficient weight to puncture the roof and explode in the attic. The molten substance scatters and spreads, making a very difficult fire to fight. In England it is recommended that attics be cleaned of any inflammable material and two inches of sand be placed over the floor of the attic. British houses are constructed of brick, whereas American houses are largely of wood. A thousand magnesium bombs dropped by the enemy in England are estimated to start 75 fires. In America the estimate is 150 fires because of wood construction.

A flying squadron of carpenters repair or condemn all bombed houses in England. More than 70,000 homes were repaired in one week's time during September 1940.

THE CIVILIAN'S PART

The worker, besides his regular duties of trying to take care of his home and family during air raids, is subject to fire-spotting duty, or auxiliary fire fighting, first aid, the home guard, or air-raid-warden duty. No compensation is given for any of these jobs except that on a fire watch during the night, a free breakfast usually is provided. Two out of every three persons between the ages of 14 and 65 are working full time in either the armed forces, civilian defense, or war industry in England. Single women between the ages of 19 and 31 are drafted for all types of war work. Married women between the ages of 20 and 45 are drafted for fire-spotting duties. Activities of children between the ages of 11 and 18 are directed to training that will eventually prepare them for a place in the war effort. The blind girls and boys are now being used in war factories for winding coils and other operations, with a surprisingly high degree of efficiency and accuracy. Industrial employees who are color blind are wanted as observers by the Royal Air Force. They can see through enemy camouflage. Camouflage is said to be no barrier to the color blind.

Labor has been co-operative to the point that strikes practically have been eliminated during the emergency. Small differences have arisen but have been adjusted quickly. Differences are settled in prewar manner by conferences. If this fails, the matter is brought up to the arbitration board whose findings are final. The hours of labor have increased from 40 and 55 to 56 and 60 hours per week per worker. Minimum office hours are 46; minimum factory hours are 52. Total earnings thus have increased approximately 30 per cent, largely because of the additional hours worked. Some 3,000,000 out of 18,000,000 workers' wages are adjusted by the cost of living index. The latest report shows that the cost of living has increased about 30 per cent, the same as the workers' income. It has been found that workers can produce more by having one day off in seven.

Retail store business has been curtailed, releasing 250,000 persons for war work in the past 14 months. Approximately 55,000,000 square feet of floor space have been liberated for more essential activities.

RATIONING AND TAXES

The present level of food rationing allows each person the following amounts of food per week: one egg; two ounces of butter; six ounces of margarine or cooking fat; eight ounces of sugar; eight ounces of cheese; two ounces of tea; approximately 20 cents' worth of meat. Canned goods, cereals, dried fruits, rice, barley, and so forth, are rationed over a four-week period according to a point system. For a month this allowance would be, per person: approximately one pound of prunes; one pound of rice; one box of cereal; and one quarter of a tin of grade-*A* salmon. Vegetables have been quite plentiful this year. One hears many complaints over the sameness of the food. Soap is rationed at three ounces per person per week. Coal for heating is rationed. The proposed reduction will be about $12^1/_2$ per cent.

Taxes are extremely high. A single worker earning $2,000 pays a total of $625 in income tax. A worker earning $3,000 pays $955 in tax. A married man earning $2,000 pays $505 in income tax. The tax is deducted weekly from wages. A part, approximately

20 per cent, of the yearly war tax will be returned to each person after the war. The amount of credit shall not be more than $260 per year per worker. In the last English budget the standard rate of income tax was raised to the all-time highest level of 50 per cent with reductions in the amount of existing allowances. Excess profits tax is now 100 per cent. Therefore, no profit can be made during the war. This is one of the steps taken by the British Government to safeguard against the risks of inflation. Another was the introduction of the coupon system which strictly limits the amount of food and clothing which may be purchased.

There are 51 clothing coupons for each man and each woman per year: man's suit 26; shirt 5; shoes 7; woolen socks 3; ladies' suit 16; pajamas 8. But the women are not giving up 8 points for pajamas. The only thing that is not rationed is the material for black-out curtains. They are making their pajamas out of this material. Pajamas made out of black-out material blend in with the night in case one has to leave the house quickly.

Electric and gas home-service departments have played a very active part in demonstrations and in publishing cooking recipes for the better use of rationed foods. They have also taken an active part in the setup of emergency canteens and cooking centers. The English people have not taken kindly to these cooking centers as they prefer, when it is practicable, to eat at home or in smaller groups. However, the British restaurants which serve cheap meals (250,000 daily) are very popular, especially in defense towns. The Ford Motor Company recently made a donation to England of $1,000,000 worth of portable kitchens which can be transported quickly from one locality to another when needed. At the beginning of the war much food and grain was stored in underground cellars, particularly prepared for this pupose.

CONCLUSION

The population lives in danger of poison-gas attacks. Continual training and preparation is being conducted to meet such attacks. With all of these problems the utility workers continue to maintain service, and the people of England continue to carry on with an undaunted spirit. Thus, life goes on with a courageous people.

Speaking of morale in England, Charles F. Palmer, former co-ordinator of United States Defense Housing, who returned via clipper, May 19, 1942, from a two-months' survey declared, "To have worked as intimately with the British as I have during the last two months is to know that Britain is waging war with all her might, with every factory, business, and home; with every pound, shilling, and penny; with every man, woman, and child. We cannot do less in America. Nothing else can win."

On completing this survey of the activities of the English in the face of a great crisis in which our colleagues are playing their own heroic role, one's mind travels quickly back across the Atlantic to the United States, which is speeding an all-out war effort.

At present one cannot conceive of Americans being subjected to the same type of blitz that has been England's lot to suffer. However, here in the United States we are liable to be subjected to token air raids for the purpose of creating fear and destroying morale. Our enemies are liable to try other types of military, incendiary, and germ surprises. Against such attacks greatest civilian protection in the United States is training—training of all employees, men and women, for just the part they must play in defense. Organization and training by local defense councils of sufficient personnel to meet all such emergencies likely to arise is desirable. Such organizations can be easily expanded where a nucleus of a trained group exists in each division.

Thorough training in first aid, fire fighting, air-raid-warden duty, emergency canteen work, ambulance service, all types of auxiliary and information service, set up by and directed by local defense councils are the greatest of all civilian protective measures.

The following is an excerpt from a letter from Miss Caroline Haslett, in London:

> On September 7, 1940, German bombers began a determined assault on London. And London, scarred but unshaken, found that the civilian arrangement made during the long months of quiet stood up to the test of war. Plans rehearsed a hundred times in dummy air raids were carried out amid the dust of fallen buildings and the glare of burning Dockland.

Here are some points that Americans well might consider regarding the waging of the war:

1. We can lose this war.
2. We have not been outfought to date, but outproduced and outmaneuvered.
3. Only arms, armies, and action count today; wealth, prestige, and $100 bills as such will not stop a tank.
4. Give the American people the facts about just what is going on; and, above all else, to tell the people the truth with the bark on it straight from the shoulder. There must be no mental coddling for the public.
5. Will it not take a long time to lick the Germans and Japanese working less than 24 hours a day, 7 days a week when, they, the Germans and Japanese, have been secretly preparing for war for years and years?

To quote Rear Admiral Marquart, "These are days of terrible war with no quarter given. Never before in our whole history has there been such a grave challenge to our country and our people, nor has our national life been in such dark peril from powerful, ruthless, and treacherous enemies."

Since December 7, 1941, we have been aroused; we have been united; we are confident that nothing will sway us from the defense of a country and the social, economic, and political principles in which we all believe.

We cannot escape nor would we escape from believing

in and fighting for the ideals which have made us free men and women of the United States of America.

Half way through the brief history of our own country, Lincoln expressed in his own simple, direct way what should be the universal prayer of us all. He said, "Let us have faith that right makes might; and in that faith, let us to the end, dare to do our duty as we understand it."

The Electric Pasteurizer

JOHN I. HALL
ASSOCIATE AIEE

The development of pasteurization is traced in this article from the experiments with wine by Louis Pasteur to the modern methods of milk pasteurizing—the holder and the high-temperature short-time methods. In the latter method electricity or hot water is used. Control, vital to the success of the process because of the necessity of holding the temperature within very close limits, is discussed in some detail as it operates in the present-day electric unit.

THE term pasteurization today applies to the process of heating every particle of a liquid to a temperature of 143 degrees Fahrenheit or more and holding at such temperature for not less than 30 minutes, or to a temperature of 161 degrees Fahrenheit or more and holding at such temperature for not less than 15 seconds. These standards have been established by the United States Public Health Service and have been termed the holder method and the high-temperature short-time method, respectively.

THE HOLDER METHOD

In the modern holder method a jacketed vessel of about 100- to 300-gallon capacity contains the milk which is brought up to pasteurizing temperature by spraying water of a controlled temperature down the outside of the vessel. This water is heated by steam injection which can be controlled either manually or automatically.

The limitations of this method are:

1. Without regeneration, which is a rather expensive item for the small dairyman, there is a loss of heat.
2. The transfer of heat to the metal wall frequently is inefficient because of conditions of film movement.
3. Certain nutritive values are affected.
4. The process is subject to human error.
5. Time and equipment are required, since it takes about one hour to process the supply in the vat.

THE HIGH-TEMPERATURE SHORT-TIME METHOD

In general, the high-temperature short-time pasteurizing equipment can be divided into two groups so far as the method of heating the liquid is concerned; one group uses electricity, the other employs hot water.

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The electrical type consists essentially of a plate regenerator and electrode chamber. The regenerator is made up of thin stainless-steel plates which are hung on parallel supports in a frame so that while the edges of a series of plates bear upon each other, the bodies have a small clearance between them. Thick rubber gaskets inserted in grooves around the edges of the plates form a water-tight seal. The frame is fitted with a screw press which holds the plates tightly together. In operation a continuous stream of milk is forced between the sections of adjacent plates.

In an installation, the plates are arranged in two sections as follows:

1. A regenerator section in which cold raw milk is sucked or forced between certain plates and the hot pasteurized milk is forced in the reverse direction between the adjacent plates.
2. A cooling section in which a refrigerating solution is forced between certain plates while the milk is flowing in the reverse direction on the opposite side of these plates.

The pasteurizing process in this machine is shown schematically in Figure 1 and a description of it follows.

Raw milk initially at a temperature of about 50 degress Fahrenheit is brought to a temperature of approximately 132 degrees Fahrenheit in the regenerator section. It then flows through the electrode chamber where its temperature is raised to 162 degrees Fahrenheit. After passing through a holding tube which maintains the milk at the critical temperature for not less than 15 seconds, it passes again through the regenerative section where it gives up part of its heat to the incoming raw milk. The temperature of the pasteurized milk is lowered to about 70 degrees Fahrenheit; thereupon it enters the cooling section where it reaches its final temperature of 50 degrees Fahrenheit or lower. It then passes directly to the bottler, after which the filled bottles

are crated and stored in a refrigerator. The process is one of continuous flow and requires a total of only 80 seconds for the complete circuit.

The single-phase electrode chamber, where the final heating occurs, is 12 inches or more in length and of a rectangular cross section. Two sides of the chamber consist of carbon electrodes separated by insulators which form the other two sides of the chamber. Current flows through the milk itself as in a water rheostat and causes sufficient heating to raise the temperature to that required for pasteurization.

It is generally agreed by authorities that the destruction of bacteria by this method is caused by the heating of the milk and not by the effects of the current or voltage.

The hot-water method of heating uses the plate-type regenerator and cooler as described, but differs in that another plate section is added where hot water is forced between certain plates and the milk already warmed in the regenerator is heated to the pasteurizing temperature between adjoining plates.

The high-temperature short-time method of pasteurization has several operating advantages which are:

1. Economy by the conservation of heat.
2. Complete enclosure of the system.
3. Reduction of space occupied by equipment.
4. Reduction in labor required.
5. Greater conservation of nutritive values in the milk (vitamin *C*).
6. Prompt operation.

HISTORY

The troubles of a poor wine maker led Louis Pasteur in 1857 to experiment with the effect of heat in checking the fermentation of wine. These studies were later extended to milk. In 1865 Pasteur announced to the Academy of Science that the maintaining of wine for a few minutes at 140 to 158 degrees Fahrenheit kept wine from spoiling.

In 1893 the first large demonstration of pasteurizing milk was made in New York where the milk was used for infant feeding, but commercial pasteurization did not begin until about 1900. Investigators since that time have found that a temperature of about 143 degrees Fahrenheit maintained for a period of 30 minutes will kill all the harmful bacteria in milk. It was also found that there is a definite time-temperature relationship which led to the establishment of the high-temperature short-hold value of 161 degrees Fahrenheit for 15 seconds.

Early electrical pasteurization was performed in England by J. M. Beattie and F. C. Lewis in 1911, where alternating current ranging between 2,500 and 6,000 volts was used. The apparatus consisted of a horizontal glass tube through which milk flowed continuously, passing through copper electrodes, one at the middle and one at each end. The success of these experiments resulted in the development of electrical pasteurization on a commercial scale.

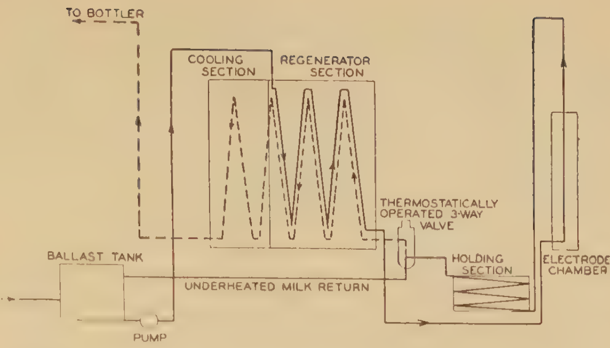


Figure 1. Flow of milk in electric pasteurizing machine

In 1914 two electrical pasteurizers were in operation in the United States, consisting of a series of porcelain cups containing electrodes with the circuit completed by the milk stream. An investigation of this type of unit in 1919 pointed out that an improved temperature control was needed, a device to assure a uniform heating, and a means to prevent underheated milk from being bottled.

Around 1920 a rectangular electrode chamber consisting of two carbon electrodes separated by suitable insulators appeared. Commercial 220-volt 60-cycle current was used and the temperature control consisted of a hand-operated micrometer valve at the entrance to the electrode chambers. A regenerative heater in which the raw milk was heated to about 120 degrees Fahrenheit by the hot pasteurized milk flowing over the outside of tubes carrying the raw milk was also used on this equipment. In 1926 two additions were made to this type of pasteurizer:

1. A constant-level tank to maintain a constant head on the centrifugal pump.
2. An automatic temperature controller to control the speed of the milk pump thereby regulating the temperature at which the milk was treated. The hand-operated valve was maintained for a rough adjustment.

In 1930 there was added a thermoelectric device to stop the milk pump should the temperature of the heated milk drop to any predetermined level. The importance of holding the temperature of the milk at a predetermined value was also emphasized, thus removing high-temperature pasteurization from a flash method to the high-temperature short-time method.

In 1937 there appeared a new unit which incorporated a constant rate of flow, an automatic means of varying the voltage at the electrode chamber to maintain a constant temperature of the milk, and a contact thermometer to stop the milk pump should the milk drop below a predetermined temperature. Subsequent changes in this equipment since that date have been the replacement of the pump-stop method by an automatic valve which returns underheated milk to the raw supply, and a plate-type regenerator or heat exchanger. A modern pasteurizing unit is shown in Figure 2.

THE CONTROL CIRCUIT

For successful pasteurization, it is essential to heat every particle of milk to the required temperature and to hold this temperature within very close limits, for if the temperature drops below 161 degrees Fahrenheit, the product is not pasteurized, and above 164 degrees Fahrenheit the amount of cream rising to the top of the bottle will be reduced.

Various step-by-step controls have been tried where the voltage across the electrodes is held constant while the rate of flow of the milk through the system is varied in response to variations of the pasteurizing temperature. The rate of flow is increased or decreased in steps as the temperature of the milk varies from the desired temperature. This control will therefore hold an average temperature close to the desired temperature, but certain sections of the milk will be overheated and the alternate sections, when the rate of flow is high, will be below the pasteurizing temperature.

Other controls have been tried where the rate of flow remains a constant and the heating effect changed in steps. With this type of control, also, because of its inherent insensitivity, the desired average temperature may be held, but alternate sections are either too hot or are below pasteurizing temperatures.

The ideal control for this type of application would be one of continuous modulation of the heating effect of the electrodes so that all sections of the milk stream will be heated to substantially the same temperature. Such control has been accomplished by employing a thermoelectric device which supplies a voltage proportional to the temperature of the milk, an amplifier which amplifies this voltage several thousand times, and a saturable reactor which regulates the voltage applied to the electrode chamber.

THE THERMOELECTRIC DEVICE

The thermoelectric device is a variable impedance bridge operated by a modulating temperature-control element which responds to the temperature of the milk. The impedance bridge has two input windings mounted on the outside legs of an E-shaped core as shown in Figure 3. These are connected in series with each other so that they set up a flux flowing in the same direction in each leg. Two output windings are also mounted on these legs of the core which are threaded by flux generated by the input windings and are arranged to oppose each other. A pivoted armature, which is operated by the bellows of the bulb-and-bellows temperature-response system, varies the amount of flux which threads the output coils by varying the air gap between the armature and core. When the two air gaps are equal, the effective output voltage becomes zero since the output windings oppose each other, but any unbalance of the flux which threads these two coils will result in the generation of an a-c voltage, the magnitude of which will depend upon the extent of the unbalance between air gaps. The core is also pivoted so that it can be adjusted, through a knob and cam, to obtain the proper relationship between the armature and bellows in obtaining the desired pasteurizing temperature.

DOUBLE CASCADED REACTOR CONTROL

The output of the impedance bridge is an a-c voltage which decreases as the temperature of the milk rises above the desired value. This voltage is rectified and the resultant direct current energizes the control coil of a small saturable reactor or amplifier. This reactor also has a bias coil which is energized from a power transformer through a full-wave rectifier. The current in the bias coil is adjusted so that it has less ampere turns than the control coil and operates in conjunction with the control coil. A decrease in the control voltage will decrease the saturating flux in the saturable reactor and decrease the a-c output. Across the a-c coil of the reactor is connected a rectifier unit to obtain a high ratio of control through regeneration, as shown in Figures 4 and 5.

The a-c coil of this reactor is in series with a full-wave rectifier which is energized from the power transformer. The d-c output of this rectifier is then a negative function of the milk temperature, for as the milk temperature increases, the output of the impedance bridge decreases. This output, acting on the control coil of the reactor, in conjunction with the bias flux, desaturates the iron and there is a corresponding increase in the reactance of the reactor a-c coil. This results in a larger voltage drop across the reactor coils and a lower output. As the temperature decreases, the action is reversed and the d-c output voltage increases. In series with this output voltage is another rectifier supplied from the power transformer which is an additional bias to limit the minimum d-c voltage.

This amplified voltage is impressed across the control coils of a large saturable reactor. The a-c windings of this reactor are in series with the electrodes of the

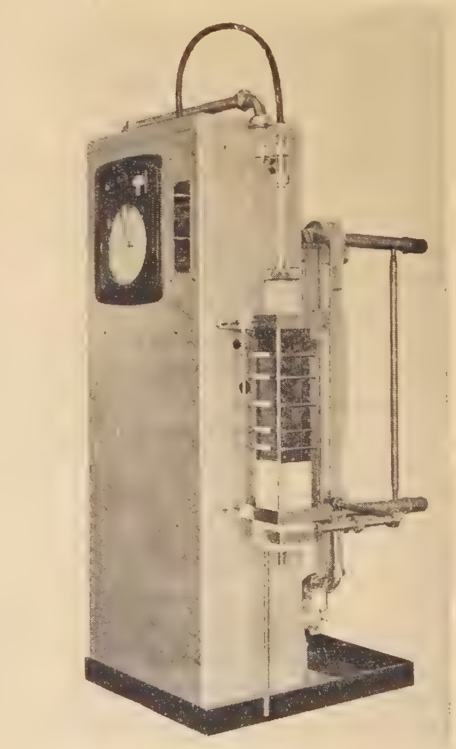


Figure 2. Electric pasteurizing unit, 1942 model, with cascaded reactor control and plate type regenerator

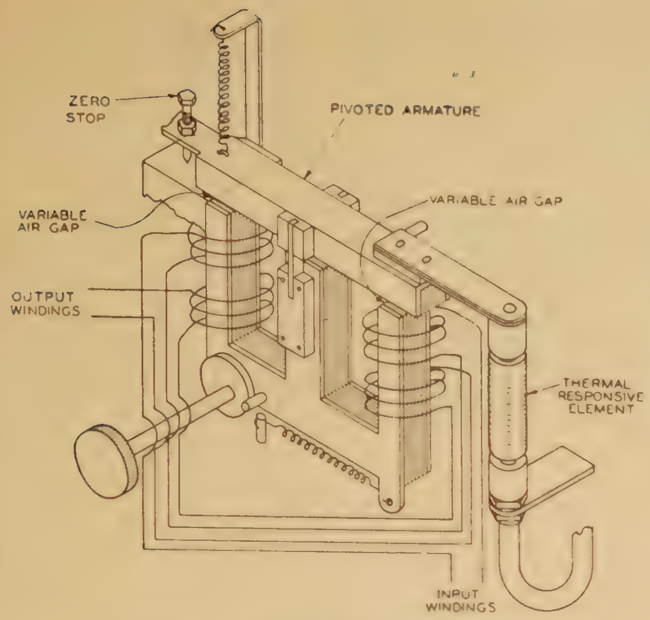


Figure 3. Variable impedance bridge

heating chamber and variation of the d-c voltage varies the a-c electrode voltage through a range of 230 volts (line) to a minimum of 140 volts. With a temperature increase of the milk, the direct current to the coil of the large saturable reactor decreases, the voltage drop across the a-c windings of the reactor increases, and the electrode chamber voltage decreases. Less heating of the milk occurs and the temperature returns to the correct value.

The large saturable reactor is of special design having two a-c coils on each leg of an E-shaped core, or four coils in all. These coils are connected so there are two a-c circuits, each circuit going through two a-c coils on

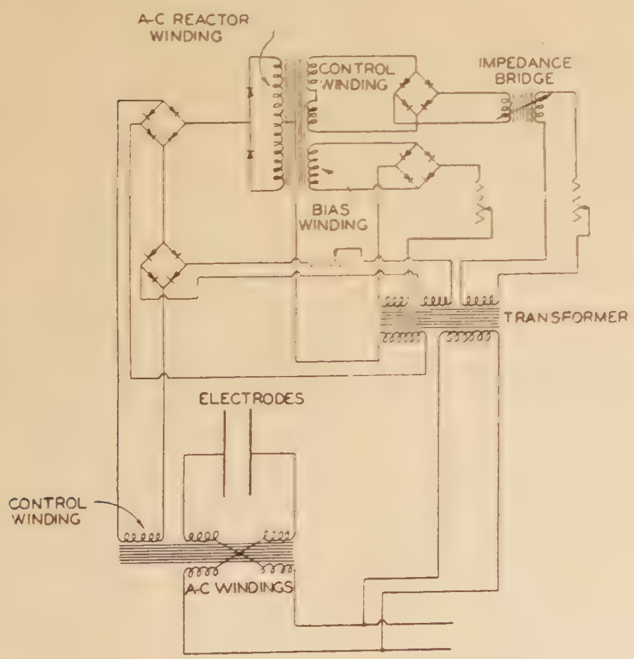
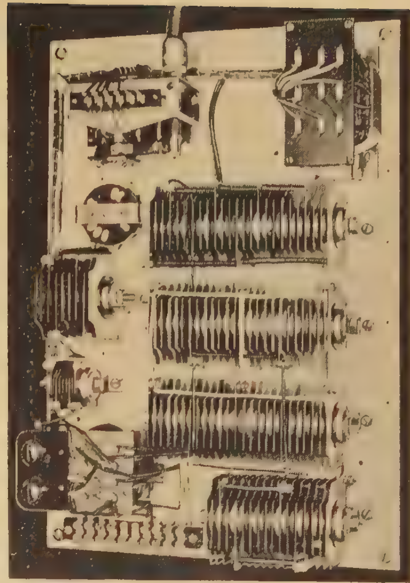


Figure 4. Wiring of cascaded reactor control

Figure 5. Control panel showing impedance bridge, first stage reactor, and rectifier units



opposite legs. By using this connection there is an equal voltage drop on each side of the line (providing the currents are equal in the two lines). Since the pasteurizer is grounded, and the center points of most 220 and 230 volt a-c systems are grounded, there is a possibility of ground current flowing, with consequent unbalanced currents in the two sets of reactor coils. If there were only two a-c coils, one on each side of the line, unequal currents in the two lines would induce an a-c voltage in the d-c control coil of the reactor. This would unbalance the system and change the heating effect on the milk. With four coils connected in the manner described, the fluxes in the two legs are always equal, no matter what ground current may be flowing.

SENSITIVITY AND AMPLIFICATION

After the proper adjustments have been made on the bias and control voltages in order to obtain the maximum degree of sensitivity without having the control overcorrect and so produce oscillations, the sensitivity will average about 18 volts per degree change in the pasteurizing temperature. That is, should the pasteurizing temperature increase one degree, the voltage across the electrodes will decrease 18 volts, thus decreasing the heating effect and restoring the desired temperature.

With these conditions the power amplification on the smallest unit is 14,000 to 1, whereas the larger units go as high as 60,000 to 1.

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Airport Lighting Under Wartime Conditions

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As a wartime expedient, certain restrictions have been placed on airport lighting. How the lighting of airports in compliance with these restrictions may be accomplished is explained here. Distinction is made between normal wartime operation of lights and black-out operation.

ONE of the more important changes deemed necessary by wartime conditions was that applying to the lighting of airports in "combat zones." In the past it has been the practice of lighting engineers to utilize all available lighting equipment commensurable with maximum visibility and safety. Now, however, the use of such equipment has been restricted, the reason for this being, naturally, that airport lighting should be available only to friendly aircraft.

These restrictions were formulated by the committee on airport and seadrome lighting, which is composed of representatives of the United States Army Air Forces, United States Navy Department, the Civil Aeronautics Administration, and the Bureau of Aeronautics and were drawn up in the form of a policy known as the Army-Naval-Civil Uniform Requirements for Operation of Aerial Lighting Aids.

THREE TYPES OF AIRPORTS

In so far as lighting is concerned, there are essentially three types of airports:

1. Strip-type fields using cone-mounted lights.
2. Strip-type fields using flush runway-marker (contact) lights.
3. All-way fields using flush contact lights.

The first type of field has strips of usable landing area which are 500 feet in width and generally composed of turf. The cone-mounted lights are placed along the periphery as shown in Figure 1(*a*). These lights serve a second purpose in that they also act as boundary lights for the safe landing area. The dashed lines show where paving can be placed if desired. Generally, however, this entails the installation of flush contact lights along the paving. Such a conversion places the field in the category of the second type of field which is shown in Figure 1(*b*). The use of the cone-mounted lights is optional. If used, they are placed along the dashed lines and serve as boundary lights. This type of field also has 500-foot landing areas, but there is a 150- or 200-foot paved runway in each one. The flush contact lights are placed along both sides of the runways. In some instances a 75-foot strip of soil-cement (a mixture of soil and Portland cement) bounds the paved runway. The area outside of the paved runway and within the confines of the landing area can be used for take-offs and landings, but only in cases of emergency. If the airport is relatively small and located near a small town, it is probable that it will not have an adequate maintenance personnel which could prevent weeds, dust, and snow from obscuring the lights. In such a case it is best to use cone-mounted lights as described in the previous case. Figure 1(*c*) shows the third type of field. The entire area is adaptable for take-offs and landings in all directions. This means that a suitable surface covers the entire field. However, it may have superimposed on it paved runways along which are flush contact lights.

Natural surroundings, soil conditions, climate, topography, number and height of structures, and air traffic are some important factors which determine a choice among the three types of airport lighting mentioned.

AIRPORT LIGHTS

In addition to the runway lights, all of the types of fields described have boundary lights, which are placed in strategic positions and so define the entire area of operations—obstacle lights that define danger zones; range lights that mark the extremities of runways; a rotating beacon that guides the aircrafts to the airport; a code beacon that provides the identifying code letter or letters; a ceiling projector that, when used in conjunction with a clinometer, determines the height of cloud strata; floodlights for runways, landing areas, and hangar aprons; a lighted wind tee and cone; taxi lights; and auxiliary lights.

Strip Type of Lighting. Previous to the promulgation of the A-N-C policy, it was customary to feed all boundary lights by a single circuit and so light them simultaneously. Connected to this circuit, through series-multiple transformers, were obstacle lights, range lights, auxiliary range lights, and the lighted wind tee. This practice has been abandoned and, in its place, there has been substituted the so-called strip type of lighting. On such a circuit there are only the cone-mounted or flush runway lights, as the case may be, the range lights, and the obstacle lights in the approach or take-off zone. All other lights are on another circuit. This confines the action to a particular runway even when other runways are available for use. Figure 2 shows a schematic diagram of an airport with the strip type of lighting. It is seen that all necessary lights are fed by one circuit.

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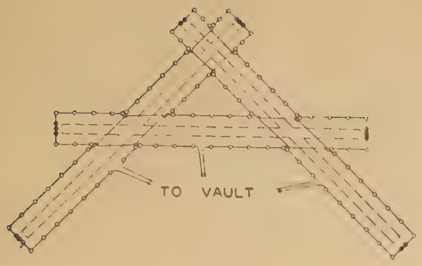
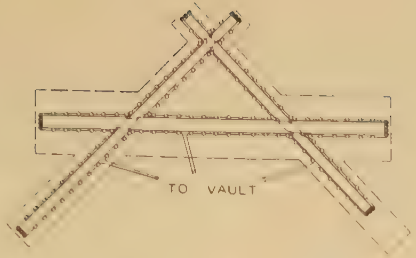


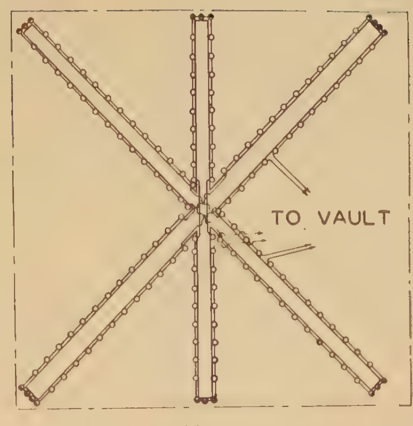
(a)



(b)

Figure 1. Airport plans showing different types of lighting

(a) *Strip-type field using cone-mounted lights*
(b) *Strip-type field using flush contact lights*
(c) *All-way type field using flush contact lights*



(c)

Operating Conditions. There are two operating conditions which are recognized under the A-N-C policy. They are normal wartime and black-out operation.

Normal wartime operation allows the use of the lighted wind indicator, the rotating airport beacon, and all turning-zone obstruction lights. Floodlights are not to be used except, possibly, in northern regions where snow may obscure flush contact lights. If the airport landing strips are lighted by cone-mounted lights, it is permissible to light all strips simultaneously. This is done by an all-on relay as seen in Figure 5. Paved runways require flush-mounted lights and are to be lighted only in the take-off or landing direction. Restrictive hoods which limit the horizontal and vertical visibility of the lights, except at the proper glide angle, are not required.

Black-out operation does not allow the use of any lights except those connected to the strip circuit. Placed over these lights are the restrictive hoods, which are shown in Figure 3. The hoods over the contact lights limit the horizontal visibility to 10 degrees to either side of a line parallel to the runway and the vertical visibility to 15 degrees above the horizontal.

Since the obstacle lights are generally mounted on trees, buildings, or poles, it is feasible to use duplex lights, each of which is equipped with a hood. One light faces the field and the other, away from the field as shown in Figure 4(*b*). All those facing one way are on one circuit, and those facing the other way are on another. Suitable switching arrangements accomplish the selection of the lights and eliminate the manual operation of reversing the hoods on single obstruction lights. Figure 4(*a*) shows a case in which a series-series isolating transformer is used, and Figure 4(*b*) shows the case for a series-multiple transformer.

The series-series arrangement shows that the switches are selective in that they can short-circuit the group of lights which are not in use. Both switches are closed when the particular runway is not in use. This also short-circuits the secondary winding of the transformer and prevents its operation with an open-circuited secondary winding. This arrangement is preferable to that shown in Figure 4(*b*) because of the inherent low power factor and low efficiency of a series-multiple transformer.

Brightness Control. The brightness of these lights is controlled by means of an auto-current-transformer equipped with taps and regulated by suitable relays. There are five taps, 100, 30, 10, 3 and 1 per cent of normal brightness. These steps are chosen with a brightness-selector switch which operates the brightness-selector relays. This is seen in Figure 5.

The range and obstacle lights are controlled simultaneously with the contact lights because all are on the same circuit. Runways with cone-mounted lights must

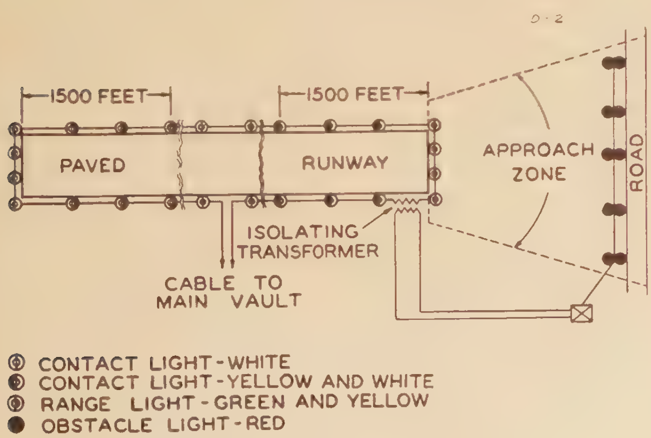


Figure 2. Strip type of lighting

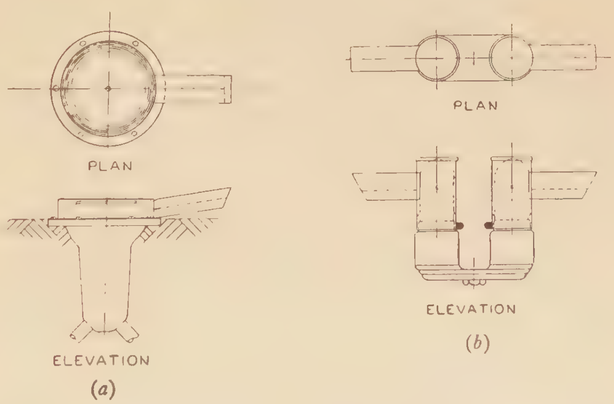


Figure 3. Lights equipped with black-out restrictive hood

(a) *Contact light* (b) *Duplex obstacle light*

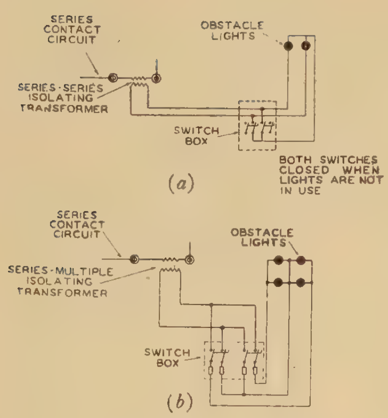


Figure 4. Wiring of obstacle lights

(*a*) *Series-series connections*

(*b*) *Series-multiple connections*

have an auto-current-transformer and a constant current regulator with a capacity large enough to carry all strips simultaneously, whereas, for paved runways having flush-mounted lights, the capacity need be only large enough to carry the largest strip circuit load.

Meaning of Colors. The color of the lights varies according to their location and each color has a definite meaning. In regard to the contact lights, those which are within 1,500 feet from either end of the runway have a split filter which shows clear from the approach end and yellow at the other end. The range lights are also equipped with a split filter and they show yellow on the inside and green on the outside. The yellow lights indicate to the pilot that he is approaching the end of the runway, and the green lights indicate the beginning of the safe landing zone. All other lights mounted on the runway, which indicate the runway itself, show clear. These lights, therefore, outline the safe take-off and landing area. Obstacle lights are red. See Figure 2.

Control Points. The normal point of control for all lighting equipment is the control tower which overlooks the airport and is located in the administration building. The switches in the control tower operate relays in the transformer vault and they, in turn, select the proper runway and brightness. The new A-N-C policy, however, requires an alternate control point located at least 150 yards from the control tower. The logical alternate point is the transformer vault which, preferably, should be underground.

Means are provided in the vault for either manual or electrical control. If manual control is desired, the control circuit from the tower to the vault must be opened by an operator in order to prevent the possibility of remote control from the tower occurring simultaneously with manual control in the vault. When remote control from the tower is resumed, care must be taken

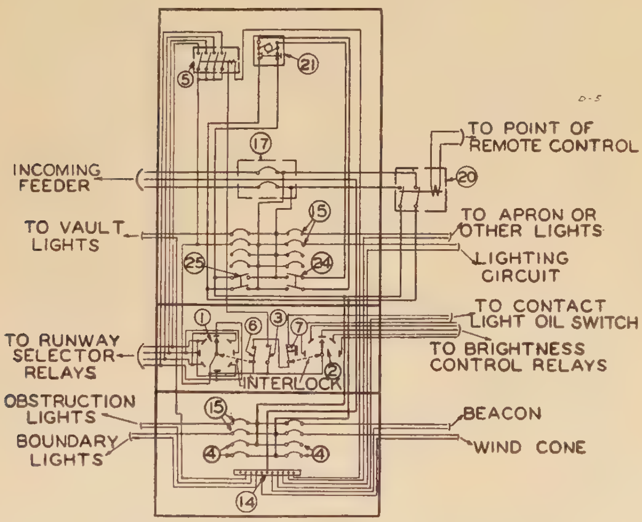


Figure 5. Details of alternate control panel

1—*Rotary switch—runway selector; eight points, one stage*

2—*Rotary switch—brightness selector; five points, one stage*

3—*Single-pole-single-throw control switch—for simultaneous operation of all lights*

4—*Air circuit breaker; spare*

5—*Relay for simultaneous operation of all lights*

6—*Contact lights switch*

7—*Switch—lock—spring return to closed position*

8—*Fused cutout; porcelain enclosed*

9—*Oil circuit breaker; remote control*

10—*Brightness-control relay; normally open*

11—*Runway-selector relay; normally closed*

12—*Distribution transformer, 2,300/230–115 volts*

13—*Disconnecting-type pothead*

14—*Grounded neutral bar*

15—*Air circuit breaker*

16—*Bus—number 6 wire, 2,300 volts*

17—*Main switch or air circuit breaker; manual*

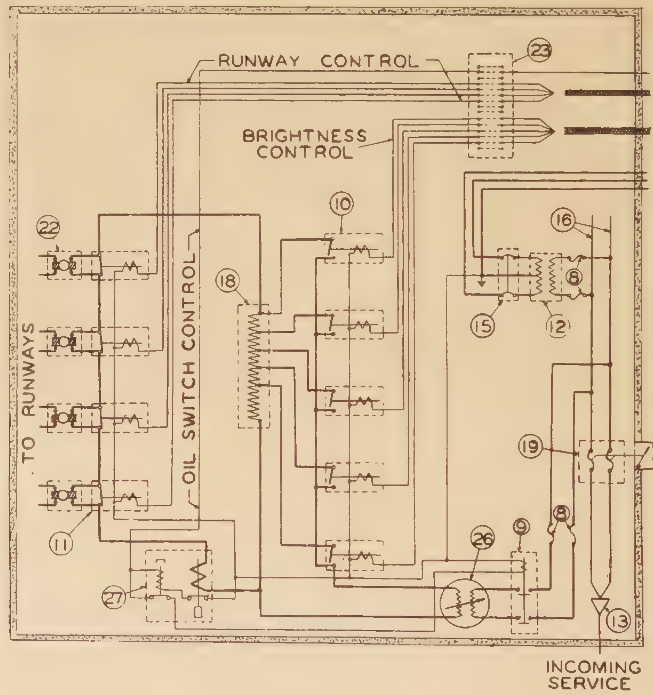


Figure 6. Typical wiring for electrical control from vault

18—*Brightness-control auto-transformer; five steps: 100%, 30%, 10%, 3%, and 1%*

19—*Oil-type cutout gang operated with remote operating handle*

20—*Remote-control contactor*

21—*Double-pole single-throw time switch 230 volts 30 amperes (minimum)*

22—*Series-plug-type cutout*

23—*Terminal box for control cable*

24—*Time switch disconnect (manual)*

25—*Control switch (manual)*

26—*Constant-current regulator, 6.6 amperes secondary*

27—*Series-protective relay*

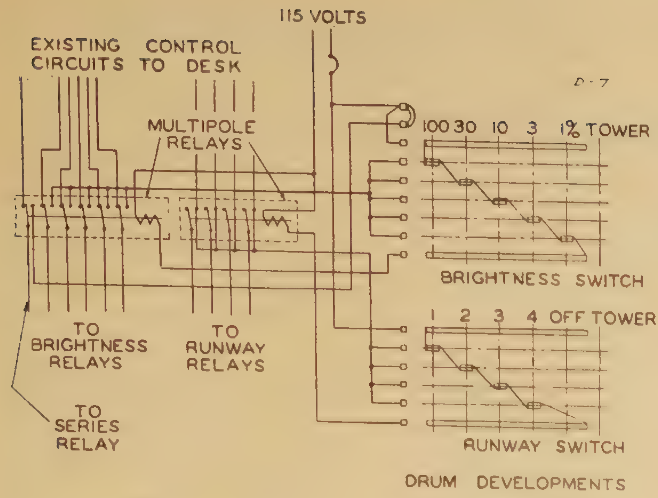


Figure 7. Connections of rotary switches

to leave the manual operating apparatus in the vault in the proper position.

The connections for manual operation are similar to those for electrical control except that hook-stick disconnect switches are connected in parallel with the contacts of the brightness-selector relay. One is needed for every tap on the auto-current-transformer. Only one switch is closed at any time and all are open when operating from the control tower. The runway is selected by blocking, in the open position, the contacts of the runway-selector relays. The changes in brightness and runways are made only when the circuits are dead. This, of course, is controlled by the primary oil switch which is also manually operated.

Electrical operation does not require an operator to disassociate the control wiring from the tower to the vault. This is provided for by transfer relays. The switches in the vault, however, must be set for control from the tower when such control is resumed. Figure 6 shows a typical wiring diagram for electrical control from the vault.

The number of poles of the two transfer relays corresponds to the number of control circuits from the control tower. When the relays are energized, they disconnect the control wiring from the tower. This is accomplished by two rotary switches with connections as shown in Figure 7. Control from the tower cannot be resumed until the rotary switches are at the position marked tower. The pull-out switch on the brightness-selector switch is for opening the remote-control oil switch when changing positions of the rotary switch. Since the pull-out switch is connected in series with the control circuit of the series-protective relay, it obviously controls the oil switch.

Control Panels and Desks. The main purpose of control panels and desks is to provide a centralized control of all lighting equipment. The size of airport, the amount of traffic, and the number of buildings available determines the type of panel or desk used.

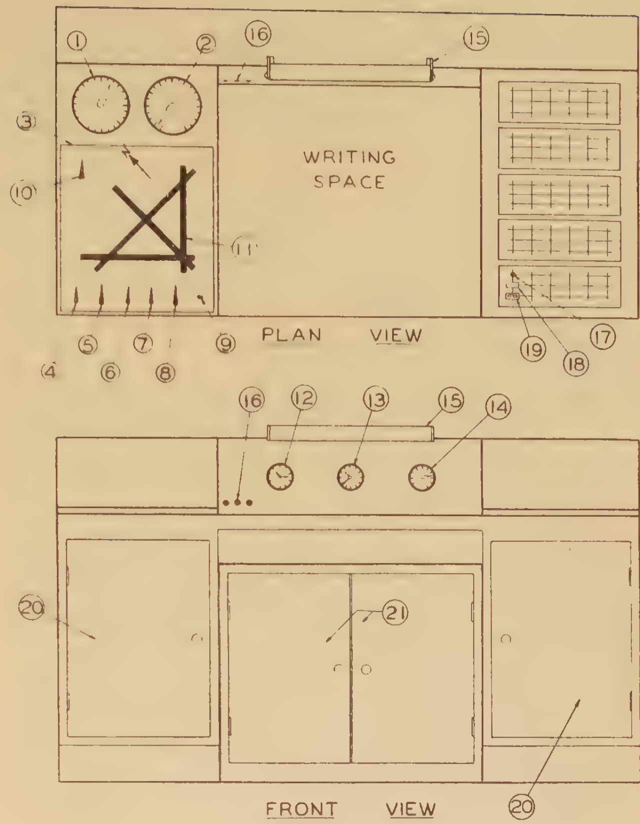


Figure 8. Typical control desk used at large airports

1—Wind-direction indicator
2—Wind-velocity indicator
3—Facsimile runway map
4—Contact-light master switch
5—Runway-selector switch
6—Floodlight master switch
7—Switch, lock, spring return
8—Brightness-selector switch
9—Tumbler switch for simultaneous operation of all runway contact lights
10—Controller pilot-light dimming
11—Runway
12—Barometric pressure (altimeter) indicator
13—Clock
14—Outdoor-thermometer indicator
15—Fluorescent desk light
16—Telephone and microphone plug bushings
17—Red pilot light, miscellaneous airport-lighting circuits
18—Name plate
19—Tumbler switch for miscellaneous airport-lighting circuits
20—Circuit-breaker and pilot-light relay compartment
21—Wiring compartment

Figure 8 shows a typical airport control desk of the type generally used in a large airport which has a glass-enclosed control tower and heavy nighttime air traffic. The control wiring of this desk conforms, in general, to that illustrated schematically in Figure 5, which shows the wiring diagram of the alternate control panel in the vault.

The facsimile map is a convenient aid to the operator, as it shows at a glance which runways are available. All the equipment needed for quick and adequate control of air traffic is within sight and easy reaching distance of the operator.

Control panels are generally used at airports that do not have adequate building facilities. They may be either of the indoor or outdoor type. In any case, they are basically alike in so far as centralization of control and wiring are concerned.

A Common Error in the Distribution Factor of Electric Machines

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A common error is often made in the use of the distribution factor of an electric machine when a winding consists of a fractional number of coils in series. This article discusses a quick and easy way of finding the correct value of this factor and a simple method for determining the best distribution of such a winding.

THE basic equation for the voltage of an alternator or a-c motor is

$$E=4.44Zf\phi_m 10^{-8}$$

where Z is the number of turns in series, f is the frequency, and ϕ_m is the maximum flux. This equation applies when all Z turns are concentrated in the same slot or in one pair of slots.

In modern practice, however, the turns are not concentrated in one pair of slots except on rare occasions. The windings are placed in a larger number of slots, so that the number of slots per pole per phase will be greater than unity. This number may be an integer, or it may be an integer plus a fraction, depending on the total number of slots, the number of phases, the speed, and the frequency. In this case the basic voltage equation will no longer hold true. When the voltage induced in a coil reaches a maximum, then the voltages of the subsequent coils will be out of phase by an amount determined by the electrical angle between the slots. These voltages must, therefore, be added vectorially, and the total will be less than would have been the case if all turns had been located in one pair of slots.

The ratio of the actual voltage to the voltage that would have resulted from the total turns, had they been located in one pair of slots, is called the *distribution factor*, k_d.

The equation now becomes

$$E=4.44Zf\phi_m k_d 10^{-8}$$

The distribution factor can be calculated by vectorially adding the voltages in the individual coils and dividing the result by their arithmetical sum.

SLOTS PER POLE PER PHASE AN INTEGER

In a machine with N slots, P poles, and m phases, there will be N/mP slots per pole per phase. The electrical angle between slots will be

$$\alpha=\frac{180P}{N}$$

The number of vectors to be added is equal to the number of slots per pole per phase, and is $s=N/mP$; by assumption this is an integer (Figure 1). The vectorial addition can be carried out as shown in Figure 2. Since $180/\alpha$ is an integer, these vectors can be considered as the sides of a regular polygon, and a circle can be circumscribed as in Figure 3. The distribution factor will then be equal to the chord AC, divided by s times the vector length AB.

It becomes

$$k_d=\frac{\sin s\dfrac{\alpha}{2}}{s\sin\dfrac{\alpha}{2}}$$

This equation holds true for any number of phases, but only when s is an integer.

Sin $s(\alpha/2)$ will be a constant for a given number of phases; it can be found to be sin $(180/2m)$. Figure 4 illustrates this for a three-phase system where each phase covers $180/3=60$ degrees.

The limit value of the distribution factor for different numbers of phases can now readily be determined by assuming an infinite number of slots per pole per phase. The polygon will then approach a circle, and the distribution factor will be equal to the chord divided by the arc over an angle equal to $180/m$.

For a three-phase system, the limit will become

$$k_{d\infty}=\frac{R}{\dfrac{180}{3}\times\dfrac{2\pi R}{360}}=\frac{3}{\pi}=0.9549\cong 0.955$$

For a two-phase machine, it becomes

$$k_{d\infty}=\frac{R\sqrt{2}}{\dfrac{180}{2}\times\dfrac{2\pi R}{360}}=\frac{2\sqrt{2}}{\pi}=0.9003\cong 0.900$$

For a single-phase machine

$$k_{d\infty}=\frac{2R}{\dfrac{180}{1}\times\dfrac{2\pi R}{360}}=\frac{2}{\pi}=0.6366\cong 0.637$$

Knowing these limits, we can tabulate the values of the distribution factor k_d for different numbers of slots

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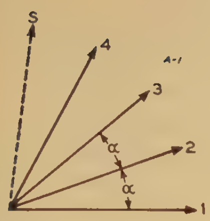


Figure 1

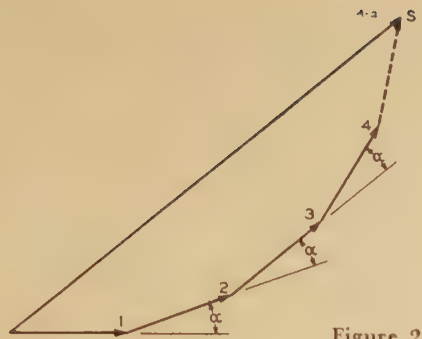


Figure 2

per pole per phase in Table I. Caution is required when these values are used for a single-phase machine, because they will not apply unless a full-pitch winding is used, and all slots contain equal live coils.

SLOTS PER POLE PER PHASE NOT AN INTEGER

It is not always feasible to use a whole number of slots per pole per phase. When a whole number of slots per pole per phase cannot be used, it is often possible to obtain a balanced winding with a fractional number of slots per pole per phase. It is possible to design a balanced winding with such a fractional value of s, if certain requirements are met: In order that the voltages of all phases will be balanced, each phase must contain an equal number of coils and, consequently, an equal number of slots, even though the number per pole will vary for the different poles. This can be stated as follows:

In order to obtain a balanced winding, it is necessary that the number of slots contains the factor m (equal to the number of phases) at least one more time than the number of poles contains that factor.

For instance, if the number of poles (12) contains the factor m (3) once (3×4), then the number of slots must contain that factor at least twice, that is m^2 ($3^2\times7$, or 63). This would make the number of slots per pole per phase $s=63/(3\times12)=1^3/_4$, and would give a balanced winding.

An error is frequently committed in the use of the distribution factor for a fractional number of slots per pole per phase. To a scientist, this error may not appear to have any justification, but an engineer can readily understand how it could happen to be made. A design engineer uses a table similar to Table I. An unsuspecting engineer is quite likely—though not justifiably so—to interpolate for a value of s between those given in the table. He is even likely to plot the values and connect the points by a curve, then reading the intermediate values from this curve. It will be shown that this is incorrect. Although in most cases the error will not be a large one, it may on certain occasions amount to several per cent. Since the distribution factor appears to the second power in some reactance calculations, the error may actually assume objectionable proportions. In order to analyze the conditions obtaining when s is not an integer, it is necessary first to consider what happens to the winding in that case.

Let there again be N slots, P poles, and m phases; in this case however $s=N/mP$ will not be an integer. Assume that c is the greatest common factor of P and N. The fraction then becomes

$$\frac{N/c}{mP/c}$$

N/c must be a multiple of m in order that the winding will be capable of being balanced. If N/c does not contain the factor m, the angles between phases will not be equal, and the phase vectors will not have the same magnitude. The fraction can now be written, when $N/c=ma$ and $P/c=b$: $s=a/b$, in which a and b are integers having no common factors. a/b is the slots per pole per phase, written as an improper fraction.

This greatest common factor c indicates the number of times that the same part of the winding is repeated. The section that is repeated contains N/c slots. This factor c, and any of its factors, therefore indicates the number of parallel circuits that can be used. A factor $c=6$ would show that 1, 2, 3, or 6 parallel circuits could be used and give a balanced winding. Each repeated section will cover P/c poles and will contain all phases. It is now necessary to determine the most advantageous manner of distributing this section over the poles and the phases. We can do this by writing numbers from 1 to N/c in a vertical column. These numbers represent the slots in a repeated section starting at an arbitrary point.

The angle between adjacent slots in electrical degrees will again be $\alpha=180P/N$.

The equivalent angular displacement between each slot and the first slot is now tabulated opposite the slot numbers. It is also possible to draw these vectors from a common center as in Figure 1. By either method it will be found that the vector which follows the last one

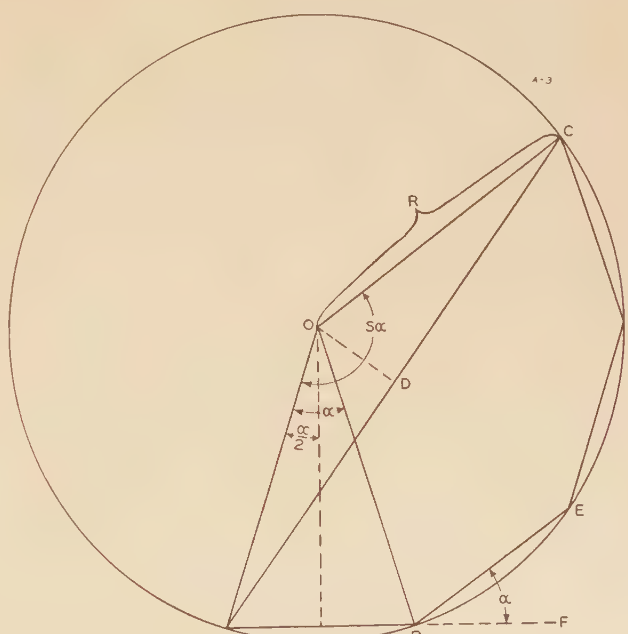


Figure 3

Table I. Distribution Factor k_d

Slots Per Pole Per Phase	No. of Phases		
S	3	2	1
1	1.000	1.000	1.000
2	0.966	0.924	0.707
3	0.960	0.911	0.667
4	0.958	0.906	0.653
5	0.957	0.904	0.647
6	0.956	0.903	0.644
7		0.902	0.642
8		0.902	0.641
9			0.940
10			0.639
∞	0.955	0.900	0.637

These values apply for all lap windings and wave windings; in the case of chain windings they apply when all slots contain an equal number of turns.

whose angle is less than 180 degrees with respect to the starting point, will not coincide with the 180-degree line. This can be proved by the fact that s is not an integer

$$\alpha = 180\frac{P}{N}$$

or

$$\frac{180}{\alpha} = \frac{N}{P} = \frac{a}{b}m$$

which by previous definition is a fraction reduced to its lowest terms (a and b having no common factors).

By referring to Figure 4, it is shown that each of the m phases covers an mth part of the first 180 degrees and again of the next 180 degrees or half-cycle. Since the second half-cycle is negative relative to the first, the vectors in the second half-cycle must be reversed, before they can be *added* vectorially to those in the first part. In Figure 5, three vectors are shown which are to be added. Since vector 3 lies within the second half-cycle, it must be reversed as shown by vector 3′; the addition can then be carried out in the usual way.

For this reason it is now possible to enter, in the third column of the tabulation, new angular values, obtained by subtracting from the values in the second column that multiple of 180 degrees which will leave a positive remainder with a numerical value below 180 degrees, so that all vectors will lie between 0 and 180 degrees. In the fourth vertical column, the phases will be shown to which the coils in the slots in column 1 belong. To do this, the angle of each phase is determined as covering $180/m$ degrees, and the slots whose angles lie between 0 and $180/m$ degrees (exclusive), between $180/m$ and $(2\times180)/m$ (exclusive), between $(2\times180)/m$ and $(3\times180)/m$ (exclusive), and so forth, will belong to the various phases. The last column will then summarize the succession of the numbers of slots belonging to the different phases in their sequence around the armature, by counting the number of times a phase is repeated before being succeeded by the next phase. A check can be made by adding the number of slots in each phase, which must be equal to a.

One point has not been mentioned before, because it does not affect the result, except when it comes to making up a winding diagram or a connection diagram. It concerns the rotation of the phases and is shown in Figure 4. In a three-phase system the starts of the phases are 360/3 degrees = 120 degrees apart. Each covers 120 degrees, divided into two halves, one part covering 60 degrees in one direction and the other 60 degrees (180 degrees later) in the opposite direction. The actual phase sequence of the coils is therefore:

$+a$	$-c$	$+b$	$-a$	$+c$	$-b$
0°–60°	60°–120°	120°–180°	180°–240°	240°–300°	300°–360°

This phase sequence must be taken into account when the phases are assigned in the last column of the tabulation.

It is now possible to consider what happens to the distribution factor in this case. It is again necessary, according to the basic definition, to add the vectors of each phase both vectorially and also arithmetically. In order to add them vectorially, we must first determine the angle between them, and prove that this angle will be the same between all vectors.

It was previously determined that a section of $N/c = ma$ coils is repeated c times and covers $P/c = b$ poles. Consequently, the first vector of the second section must coincide with the first vector of the first section; since all vectors are considered to lie between 0 and 180 degrees (the others being reversed), it is necessary to determine how many times this 180 degrees is traversed before two vectors will coincide. This is given immediately by the fact that the repeated section covers b poles or $b\times180$ degrees, since each pole covers 180 degrees. The ma vectors per repeated section, which are α degrees apart, have a total angle of $ma\times\alpha$ degrees, which is equal to $b\times180$ degrees. However, all these vectors lie between 0 and 180 degrees. The first 180 degrees, the vectors are equally spaced α degrees apart. The next 180 degrees they will lie between those of the first 180 degrees. The next 180 degrees, they will again lie between those of the first and second section and so on, until after b times the vector will coincide with those previously present. Since the interval between vectors successively drawn is always equal to the angle between slots, the overlap will always be the same, and the successive vectors within the 180 degrees will be $\alpha_1 = 180/ma = \alpha/b$ degrees apart. Therefore, there will be a vectors per phase, α_1 degrees apart.

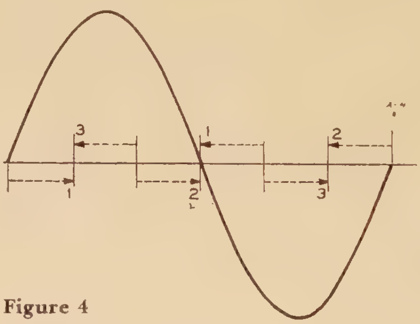


Figure 4

Another way of arriving at the same result is by considering that all vectors for the same phase lie evenly

distributed within an angle of 180/m degrees. Because there are a slots per phase in each section, the angle will be

$$\alpha_1 = \frac{\frac{180}{m}}{a} = \frac{180}{ma}$$

To explain this more clearly, suppose that the minute hand on a watch is advanced by intervals of 18 minutes starting at 12 o'clock, and that the positions at which the hand stops are marked on the face. The fourth time the hand will stop at 72 minutes or 72−60=12 minutes. The seventh time it will stop at 126, or six minutes, and the tenth time it will stop again at 12 o'clock. The hour hand will have moved from 12 to 3. What we actually did was to find the least common multiple of 60 and 18, which is 180. The angle between points marking the stops is then found by finding the smallest fraction of 60 and 18, namely 60/18=10/3. The angle between successive marks on the face will then be 60/10 or 18/3=6 minutes.

Similarly, we find the least common multiple of 180 degrees and α degrees. Since $\alpha = 180b/ma$, where b/ma is irreducible, the least common mutiple will be $180 \times b$. The angle between vectors will therefore be:

$$\alpha_1 = \frac{\alpha}{b} \text{ or } \alpha_1 = \frac{180}{ma}$$

Adding these a vectors vectorially gives

$$2R \sin \frac{a\alpha_1}{2}$$

and adding them arithmetically gives

$$2Ra \sin \frac{\alpha_1}{2}$$

The distribution factor is therefore

$$k_{d1} = \frac{2R \sin a\frac{\alpha_1}{2}}{2Ra \sin \frac{\alpha_1}{2}} = \frac{\sin a\frac{\alpha_1}{2}}{a \sin \frac{\alpha_1}{2}}$$

Since $\alpha_1 = \frac{180}{ma}$, we have

$$\sin a\frac{\alpha_1}{2} = \sin a \frac{\frac{180}{ma}}{2} = \sin \frac{180}{2m} = \sin \frac{90}{m}$$

and

$$a \sin \frac{\alpha_1}{2} = a \sin \frac{90}{ma}$$

Therefore

$$k_{d1} = \frac{\sin \frac{90}{m}}{a \sin \frac{90}{ma}}$$

For an integral number of slots per pole per phase, the distribution factor was found to be

$$k_d = \frac{\sin s\frac{\alpha}{2}}{s \sin \frac{\alpha}{2}}$$

$$\alpha = 180\frac{N}{P} \text{ and } \frac{P}{N} = sm, \text{ therefore } \alpha = \frac{180}{sm} \text{ and}$$

$$k_d = \frac{\sin s\frac{180}{2sm}}{s \sin \frac{180}{2sm}} = \frac{\sin \frac{90}{m}}{s \sin \frac{90}{sm}}$$

By comparing k_d and k_{d1}, it is now seen that the two formulas agree in form.

To find the correct distribution factor in the case of a fractional number of slots per pole per phase, it is therefore necessary only to substitute a for s in the formula for the distribution factor for a whole number of slots per pole per phase. And a can be determined readily by writing the slots per pole per phase as an improper fraction. It is the numerator of that fraction. The denominator of the fraction does not appear in the result and is therefore immaterial as far as determining the effects of such a winding is concerned.

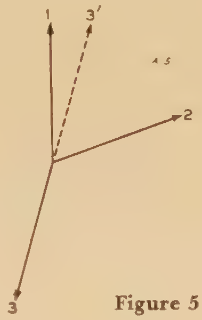


Figure 5

It is therefore possible to use the same table (Table I) for the distribution factor, regardless of whether the number of slots per pole per phase in an integer or a fraction. Interpolation is unnecessary and incorrect.

CONCLUSION

The electrical results of the use of a fractional number of slots per pole per phase are therefore the same as would have resulted from a larger number of slots, which would have given a whole number of slots per pole

Table II

Slot Number	Angle	Equivalent Angle	Phase	Grouping
1	0	0	*a*	
2	50	50	*a*	2
3	100	100	*c*	1
4	150	150	*b*	1
5	200	20	*a*	1
6	250	70	*c*	1
7	300	120	*b*	
8	350	170	*b*	2
9	400	40	*a*	1
10	450	90	*c*	1
11	500	140	*b*	1
12	550	10	*a*	1
13	600	60	*c*	
14	650	110	*c*	2
15	700	160	*b*	1
16	750	30	*a*	1
17	800	80	*c*	1
18	850	130	*b*	1

per phase equal to the numerator of the improper fraction expressing the slots per pole per phase, reduced to the smallest terms.

The design engineer should throw away his curve or interpolations and use the correct values from Table I. It will be less trouble to use the right value than the erroneous one previously used.

An example will be given to illustrate the method and to show the magnitude of the error.

EXAMPLE (SEE TABLE II)

The coil grouping and the distribution factor are to be determined for the following machine, having $P=20$ poles, $m=3$ phases and $N=72$ slots.

First it must be determined whether this combination can give a balanced winding, as follows

$$\frac{N}{P}=\frac{72}{20}=\frac{72/4}{20/4}=\frac{18}{5}$$

Since 18 is divisible by 3, the winding can be balanced. s will then be

$$s=\frac{N}{mP}=\frac{72}{3\times 20}=\frac{6}{5}=\frac{a}{b} \quad \text{and}$$

$a=6$, $b=5$, and $c=4$ (1, 2, and 4 parallel circuits are possible)

$$\alpha=\frac{180P}{N}=50°$$

$$\alpha_1=\frac{\alpha}{b}=\frac{50}{5}=10°$$

It is now possible to enter the proper values in the first three columns of Table II. In order to assign the three phases a, b, and c to the various slots and fill in column 4, it is necessary to consider the phase rotation as in Figure 4. It is then found that phase a is assigned to angles between 0 degrees and $180/3=60$ degrees (exclusive), phase b to angles between $(2\times 180)/3=120$ degrees and $(3\times 180)/3=180$ degrees (exclusive) and phase c to angles between $180/3=60$ degrees and $(2\times 180)/3=120$ degrees (exclusive). When the fourth column has been completed, the coils are grouped as in column 5.

The angles for the vectors of phase a will then be 0°–50°–20°–40–10°–30°, or 6 vectors, 10 degrees apart.

The distribution factor will be

$$k_{d1}=\frac{\sin\frac{90}{m}}{a\sin\frac{90}{ma}}=\frac{\sin 30}{6\sin\frac{90}{18}}=0.956$$

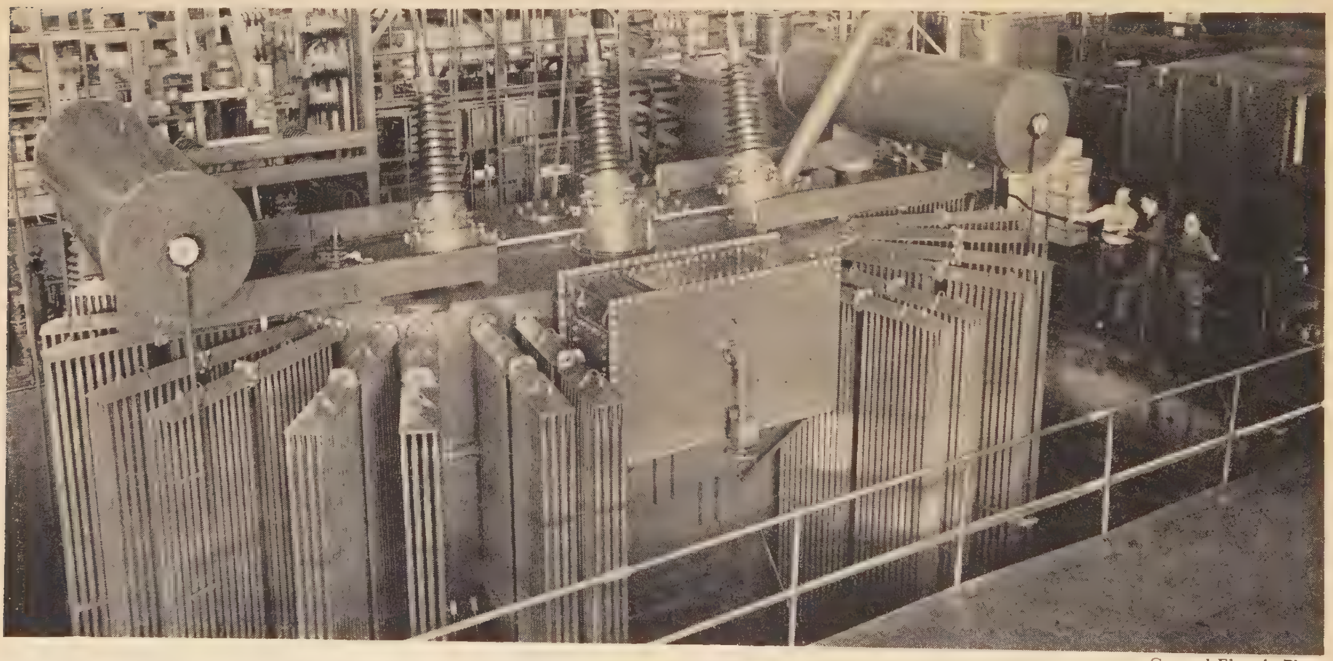
From the table, for $s=6$ and 3 phases. $k_d=0.956$.

The value taken from a curve would be 0.982; by interpolation it would be 0.993.

The error in the first case would be 2.72 per cent, and in the second case 3.87 per cent.

The error in the reactance value would be 5.5 per cent in the first case and 7.9 per cent in the second case, since the distribution factor occurs to the second power in the equation for that value.

The errors can, of course, become still larger for two-phase and for single-phase machines.



General Electric Photo

This transformer, being installed on the Brooklyn (N. Y.) Edison system, has a rating of 75,000 kva, 60 cycles, and 132,000 volts, with two separate low-voltage windings, each for 13,500/27,000 volts. The equivalent two-winding rating is 84,000 kva. Provision is made for addition of forced-air cooling whereby the rating can be raised to 150,000 kva

INSTITUTE ACTIVITIES

North Eastern District Technical Meeting to Be Held April 8–9

A technical meeting of the AIEE North Eastern District will be held on April 8 and 9, 1943, at Pittsfield, Mass., with headquarters at the Wendell Hotel. Subjects of importance to electrical engineers in fulfilling their professional duties in war time will be stressed at the meeting.

Five technical sessions on the tentative program are planned to cover the following subjects:

Electronics, a field that is being greatly stimulated by the war.

Power transmission and distribution, and industrial control and power applications, two subjects of primary importance as industry strives to achieve maximum output.

Measurements and instrument transformers, new developments in the field.

Plastics, which are playing an important part in the war effort.

Technical papers will be presented in all five of these categories.

It is planned also to hold three conferences to facilitate the free exchange of ideas on problems of present-day importance to engineers. These include a clinic for industrial operators of electrical equipment at which methods of getting the most from available apparatus will be discussed; ways in which the engineering profession can make the greatest contribution to the community will be the subject of a conference on engineering councils; and the place of the engineer in the war effort will be discussed at another conference on the wartime problems of technical personnel.

Since AIEE members must keep abreast of technological developments important to the war effort, with the minimum expenditure of time, a full technical program is being presented in two days, rather than in three days as in past years, by retaining in the program only those elements that are essential under present circumstances.

National Technical Meeting Report to Appear in March Issue

As this issue of *Electrical Engineering* goes to press the 1943 AIEE national technical meeting is in progress in New York, N. Y. Indications are that this meeting, keyed to many phases of the war activity, will be equally as successful as others held in recent years, despite war conditions. Registration for the first two days is reported to be 1,115 as compared with 1,059 for the first two days of 1942 meeting, 1,278 for 1941, 1,178 for 1940, and 1,159 for 1939.

A full report of the meeting will be published in the March issue.

Future AIEE Meetings

District Technical Meeting
Pittsfield, Mass., April 8–9, 1943

District Technical Meeting
Kansas City, Mo., April 28–30, 1943

National Technical Meeting
Cleveland, Ohio, June 21–25, 1943

No Fortescue Fellowship Award to Be Made for 1943–44

Because of conditions brought about by the war, there will be no meeting of the Fortescue Fellowship committee and no award of the Charles Legeyt Fortescue Fellowship, which annually provides graduate fellowships in electrical engineering, for the year 1943–44. The funds available are to be impounded. Suspension of the award is in accordance with a motion passed at a meeting of the Fortescue Fellowship committee held on March 25, 1942.

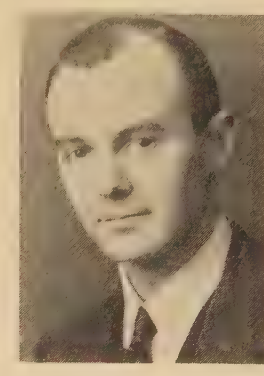
AIEE Advertising Manager, C. A. Graef, Dies

Charles A. Graef, AIEE advertising manager for the past 20 years, died January 20, 1943 at his home in Brooklyn, N. Y., at the age of 53. He had been ill for several months.

Mr. Graef was born in New York, N. Y., and was educated in public and high schools in Brooklyn. During World War I he served overseas, and after the armistice was an official stenographer in Paris, France, for the Peace Commission. He became associated with the AIEE in 1911, and had been advertising manager since 1923.

PERSONAL • • • •

G. W. Dunlap (A '35, M '42) development engineer in the laboratories of the General Electric Company, Schenectady, N. Y. has been awarded the Alfred Noble prize for 1942 for his paper, "The Recovery Voltage Analyzer for Determining of Circuit Recovery Characteristics" (AIEE *Transactions*, volume 60, 1941, November section, pages 958–62). He was born on April 13, 1911, in Gardnersville, Nev., and received from Stanford University the degree of bachelor of arts in 1931, that of engineer in electrical engineering in 1933, and that of doctor of philosopy in 1936. From 1932 to 1935 he held the Harris J. Ryan High-Voltage Research Laboratory Fellowship. In 1935 he entered the testing department of the General Electric Company in Schenectady and was transferred in 1936 to the high-voltage and impulse section of the general engineering labora-



G. W. Dunlap

tory. There he is responsible for the development and application of devices concerned with measurements in the field of high-voltage and high-speed transients. In 1933 he won the AIEE San Francisco Section prize for the best student paper. He is also a member of Sigma Xi and Tau Beta Pi.

D. C. Jackling (M '41) managing director, mining operations, Kennecott Copper Corporation, San Francisco, Calif., has retired. He will continue as a director of that company. Mr. Jackling was born on August 14, 1869, at Hudson, Mo., and received from the Missouri School of Mines and Metallurgy the degrees of bachelor of science in 1892, metallurgical engineer in 1900, and doctor of engineering in 1933. He holds the honorary degrees of doctor of laws from the University of California, and doctor of engineering from the University of Southern California. He began his career as a rodman and instrument man on the Missouri, Kansas, and Texas Railroad in 1890 and 1891. For the following two years he was assistant professor of chemistry and metallurgy at the Missouri School of Mines and Metallurgy, Rolla. Then came two years with the Lawrence Gold Extraction Company, Colo., as miner, assayer, metallurgist, and mill superintendent. In 1896 he built and operated an experimental mill at Mercur, Utah. From 1897 to 1900 he was engaged in building and operating, at Mercur, a gold mill, which was one of the first to be built entirely of steel and concrete and to be driven exclusively by electric power, using 3-phase alternating current. From 1900 to

1922 he developed mine properties, and designed and constructed plants for treating their ores, in Utah, Nevada, Arizona, Alaska, Colorado, Montana, and New Mexico. The mines involved included those of the United States Reduction and Refining Company, the Butts and Superior Mining Company, the Alaska Gold Mines, the Mesabi Iron Company, the Gallup American Coal Company, the Utah Copper Company, the Ray Consolidated Copper Company, the Chino Copper Company, and the Nevada Consolidated Copper Company. He was most closely associated with the last six companies, of which he became president. Studies made in his early days at Mercur on the possibilities of commercializing low-grade ores led to the establishing of the Utah Copper Company. Since 1922 he has been engaged in executive work in the mining industry. He received the United States Distinguished Service Medal in 1919, the gold medal of the Mining and Metallurgical Society of America in 1926, the William Lawrence Saunders Gold Medal of the American Institute of Mining and Metallurgical Engineers in 1930, the John Fritz Medal of the Engineering Societies of New York in 1933, and the Washington Award in 1940.

William Wilson (M '23) assistant vice-president of Bell Laboratories, Inc., New York, N. Y., has retired. He was born March 29, 1887, at Preston, England, and was educated at the Universities of Manchester and Cambridge. He received the degrees of bachelor of science, master of science, and doctor of science from the former and the degree of bachelor of arts from the latter. Mr. Wilson's retirement terminates a 28-year association with the Bell Telephone system. His first position with the company, in 1914, was that of an observer on transcontinental wireless telephone tests at the San Diego, Calif., station. From 1914 to 1923 he was charged with development and research work on vacuum tubes in the research department of the Western Electric Company, Inc., New York, N. Y. During 1918 he supervised the manufacture of power tubes for that company. He held the position of assistant director of research of the Bell Laboratories from 1927 to 1936. As such, he organized research on problems of wire and radio communication. Since 1936 he had been assistant vice-president in charge of personal relations. Before joining the Western Electric company, Mr. Wilson lectured on physics at the University of Toronto for two years. He holds patents on vacuum tubes and is the author of articles in English and German on radioactivity, thermionics, vacuum tubes, and radio. He is a fellow of the American Physical Society, and a member of the Institute of Radio Engineers.

R. F. Pack (A '11, M '12) president of the Northern States Power Company, Minneapolis, Minn., has retired from the presidency of the company to become chairman of the board. He was born on October 1, 1874, on the Isle of Wight. He was employed by the Toronto Electric Company in 1891 and became successively accountant, comptroller, secretary, and general manager. In 1912 he became associated with the Byllesby Engineering and Management Corporation, Chicago, Ill., as general manager of the Minneapolis General Electric Company, Minn. (now a division of the Northern States Power Company). He was appointed general manager of the Northern States Power Company in 1916 and shortly afterwards, vice-president, and later, president. In 1936 he was elected to the board of directors of the Byllesby company. He will continue as president of the Northern States Power Company of Delaware.

S. C. Medbery (A '02, M '30) engineer of maintenance practices for the New York (N. Y.) Telephone Company, retired on January 1, 1943. He was born on September 7, 1878, at Ballston Spa, N. Y., and graduated from Union College with the degree of bachelor of science in electrical engineering. His engineering career began in the testing department of the General Electric Company in 1899. From 1901 to 1904 he was electrician in charge of central stations for the Virginia Passenger and Power Company, Richmond. In 1905 he joined the New York and New Jersey Telephone Company doing tests and inspections. In 1907 he joined the engineering department of the New York Telephone Company, where he worked on inductive co-ordination, transmission, electrolysis, and equipment maintenance practices. In 1925 he was made engineer of maintenance practices.

J. I. Hull (M '16) assistant to the manager of the River Works of the General Electric Company, West Lynn, Mass., has been appointed to full-time service as engineer in charge of the Thomson Laboratory of the River Works. Since 1937 Mr. Hull has held the two positions of assistant to the manager on engineering activities and engineer in the Thomson Laboratory. He received his bachelor of philosophy degree from Yale University in 1908 and his bachelor of arts degree from that university in 1909. He began his career in the testing department of the General Electric company's works in Pittsfield, Mass. In 1910 he was transferred to the General Electric company in Schenectady, N. Y., where he was designing engineer in the induction motor department until 1930. In 1931 he became assistant to the manager of the West Lynn River Works.

D. L. Beeman (A '31) industrial engineering department, General Electric Company, Schenectady, N. Y., has recently been appointed engineer, industrial power section. He received the degree of bachelor of arts in electrical engineering from Stanford University in 1929, and immediately entered the employ of the General Electric Company in the test course as student engineer. He was engaged subsequently on test work at that company's plants in Pittsfield, Mass., and Philadelphia, Pa., and later was transferred to the relay-engineering division of the switchgear department in Philadelphia. In 1935 he joined the air-circuit-breaker engineering division there, and in 1936 he was transferred to the central-station engineering department at Schenectady, N. Y. He has been an application engineer in the industrial power section since 1941.

A. F. Connery (A '23) inside engineer, plant and engineering department, has been appointed chief engineer. He was employed (1917–20) with the Great Northwestern Telegraph Company, at Winnipeg, Man., Saskatoon, Sask., and Montreal, Que. and the Western Union Telegraph Company, New York, N. Y. (1920–22). He first joined Postal Telegraph-Cable Company in 1922, serving until 1928 as inside plant engineer. Subsequently he served in a similar capacity for International Telephone and Telegraph Company, International Communications Laboratories, and the All America Cable Company. He rejoined the Postal Telegraph Company in 1939 as equipment engineer, and has been associated with that company continuously since that time.

W. N. Lindblad (A '37, M '41) assistant chief, bureau of test and inspection, Pacific Gas and Electric Company, Emeryville, Calif., recently has been appointed chief of the test and inspection bureau. He has been associated with Pacific Gas and Electric Company continuously since 1913, except for a brief period during World War I when he served from 1918 to 1919 in the United States Army Air Service. From 1913 to 1914 he was employed as a meter tester, and since then has served successively as laboratory assistant (1914–17), assistant superintendent of the electrical laboratory (1917–19), and assistant chief to date. He was graduated from Polytechnic College of Engineering in 1913.

J. O. Walz (A '21, M '42) manager of engineering, small motor engineering department, Westinghouse Electric and Manufacturing Company, Lima, Ohio, has recently been appointed assistant manager of the division. He was transferred to the Lima works from the Westinghouse student course in East Pittsburgh, Pa., in which he was enrolled from 1918 to 1919. He has been associated with the small motor engineering department since 1919, serving successively as design engineer, section engineer, and ultimately as manager of engineering.

W. R. MacDonald, Jr. (A '33) formerly captain in the Signal Corps, United States Army, with headquarters at Washington, D. C., has recently been appointed a major. He is now head, editing subsection, literature section, military training branch, Office of Chief Signal Officer, Washington, D. C. He has been with this office since his commission in 1941 as first lieutenant. He is now on wartime leave of absence as

assistant editor for the American Institute of Electrical Engineers, where he has been employed in the editorial department since 1934.

J. O. Johnson (A '36) chief product engineer of the Aircraft-Marine Products, Inc., Elizabeth, N. J., has been made assistant merchandise manager of that company. From 1931 to 1934 he was employed by Sears, Roebuck and Company, first in the office of the technical director and later in the merchandise development division. He worked as junior material engineer and assistant material engineer in the laboratory of the Brooklyn Navy Yard from 1934 to 1940, when he joined the Aircraft-Marine company.

H. W. DeWitt (M '40) engineer, maintenance and related matters, New York (N. Y.) Telephone Company, has been transferred from the Manhattan-Bronx-Westchester area to the operations and engineering department, to work in the appraisal practices group of the operating results division. Mr. DeWitt has been with the New York Telephone Company since he graduated from Stevens Institute of Technology with the degree of mechanical engineer in 1927.

G. Ross Henninger (A '22, M '27) AIEE editor on leave, has been assigned to the Air Service Command at Patterson Field, Fairfield, Ohio. Lieutenant Colonel Henninger is now chief of the Reproduction Branch of the Technical Data Section, which is charged with assembling technical data for the United States Air Forces throughout the world. He was formerly liaison officer on the headquarters staff of the Army Specialist Corps in Washington, D. C.

R. R. Donaldson (M '17) vice-president of the Utility Management Corporation, New York, N. Y., has been made head of a department to render advisory and supervisory services to operating utilities for Gibbs and Hill, Inc., New York, N. Y. Mr. Donaldson received the degree of mechanical engineer from Cornell University in 1907. He joined the Utility Management Corporation in 1926 as assistant chief engineer.

G. W. Swenson (A '19, F '36) professor of electrical engineering and head of the department, Michigan College of Mining and Technology, Houghton, has been granted leave of absence to accept a position as special consultant with the United States Army Air Force, Orlando, Fla. **Chester Russell, Jr.** (A '29, M '34) associate professor of electrical engineering at the college, has been appointed acting head of the department in his absence.

Thomas Ingledow (M '41) chief engineer, British Columbia Electric Railway Company, Ltd., has been elected chairman of the AIEE Vancouver Section for 1942–43. Other officers include **T. F. Hadwin** (A '35) assistant superintendent, construction and maintenance, British Columbia Electric Railway Company, Ltd., vice-chairman; and **F. V. Knight** (A '25) substation operator, British Columbia Electric Railway Company, Ltd., as secretary.

L. O. B. Lindstrom (A '22) sales representative, General Electric Company, San Francisco, Calif., has become a partner in the A. E. Smith Engineering Company, San Francisco, Calif. He had been associated with General Electric Company since 1920. Prior to that time he worked briefly as operator (1919–20) with the Utah Power and Light Company, and as electrician on construction (1920) for the Southern California Edison Company.

David Williams (A '23) manager, electrical and mechanical equipment purchases, purchasing and stores department, Consolidated Edison Company of New York (N. Y.), Inc., has been appointed lieutenant commander, United States Naval Reserves, and is now on duty as head of the engineering section, commodities branch, purchase division, Bureau of Supplies and Accounts, Washington, D. C.

J. E. Piccardo (A '36) chief engineer, Jacuzzi Brothers, Inc., Berkeley, Calif., has been appointed mechanical engineer in production, San Francisco Ordnance district, United States War Department. He has been associated with Jacuzzi Brothers, Inc., since his graduation from the University of California with the degree of bachelor of science in electrical engineering in 1935.

H. V. Schofield (A '40) equipment engineer, Illinois Bell Telephone Company, Chicago, has been transferred to the operations and engineering department of the New York (N. Y.) Telephone Company where he will take charge of the group handling engineering matters relating to central office and private-branch-exchange equipment. He has been with the Illinois company since 1927.

C. F. Scott (A '92, F '25, HM '29) professor of electrical engineering emeritus, Yale University, New Haven, Conn., has been appointed a member of the sectional committee on definitions of electrical terms of the American Standards Association. Doctor Scott is a past president (1902–03) and past vice-president (1899–1901) of the Institute. He received the Edison Medal in 1929.

J. C. Michalowicz (A '41) assistant research engineer, technical standards department, Rural Electrification Administration, Washington, D. C., has been appointed instructor in the department of electrical engineering, The Catholic University of America, Washington, D. C. He received the degree of bachelor of electrical engineering from that institution in 1940.

Gregory Timoshenko (A '33, M '39) assistant professor of electrical engineering, University of Connecticut, Storrs, has recently been appointed associate professor. Before joining the teaching staff of the engineering department at that institution he served as instructor in electrical engineering (1934–39) at Massachusetts Institute of Technology.

R. B. Shepard (A '25, F '36) deputy chief of the simplification branch of the bureau of industrial conservation of the War Production Board, Washington, D. C., has been appointed chief of the simplification branch. At the time of his appointment to the WPB he was chief electrical engineer, Underwriters Laboratories, Inc., New York, N. Y.

E. B. Whitman (M '34) partner, Whitman, Requardt, and Smith, Baltimore, Md., consulting engineers, has been elected president of the American Society of Civil Engineers. He was graduated from Cornell University in 1901 with the degree of chemical engineer, and has served as a past director of the society.

F. R. Lack (M '37) vice-president and manager, radio division, Western Electric Company, New York, N. Y., is on leave of absence serving as director of the Army–Navy Electronics Expediting Agency. He will supervise all Army and Navy joint activities expediting production of communications and radio equipment.

W. J. Russell (M '37) manager of engineering, Westinghouse Electric and Manufacturing Company, Mansfield, Ohio, has been awarded the Westinghouse Order of Merit, "in recognition of distinguished service in the field of engineering." He has been with the Westinghouse company since 1923.

Ellis Blade (A '35) consulting engineer. and formerly chief engineer of the spring division, John Chatillon and Sons, New York, N. Y., has recently been appointed a wire and cable specialist for the United States Army Signal Corps, with headquarters in Washington, D. C.

D. L. Smith (M '27) engineering assistant to the executive officer, Chicago (Ill.) Rapid Transit Company, has been ordered to active duty with the United States Army Field Artillery Reserves, as lieutenant colonel. He is stationed in San Francisco, Calif.

James J. Pilliod (M '17, F '34) general manager of the long-lines department of the American Telephone and Telegraph Company, New York, N. Y., has been given a leave of absence to join the production division, Services of Supply of the War Department, Washington, D. C.

F. M. Farmer (A '02, F '13) vice-president and chief engineer of the Electrical Testing

Laboratories, New York, N. Y., has been elected vice-president of the United Engineering Trustees. He is a past president (1939–40) of the Institute.

J. R. Shoffner (A '29, M '37) chief engineer of the Allegheny River Mining Company, Kittanning, Pa., since 1936 has been elected state director, representing Pittsburgh, on the executive board of the Pennsylvania Society of Professional Engineers.

William Biester (A '41) president of the Electric Construction Company, Philadelphia, Pa., has been appointed an alternate member of the American Standards Association's sectional committee on the national electrical code.

Leonard T. Blaisdell (A '20, F '39) commercial vice-president of the General Electric Company, Cleveland, Ohio, has received the honorary degree of electrical engineer from the Case School of Applied Science.

A. R. Williams (M '31, F '35) lieutenant colonel, United States Army, formerly with the power branch of the War Production Board has been made chief of the power section of the Army and Navy Munitions Board.

O. E. Buckley (M '19, F '29) president of the Bell Telephone Laboratories, Inc., New York, N. Y., has been appointed by the War Production Board to a committee which will set up the proposed Office of Technical Development within the WPB.

L. W. Chubb (A '09, F '21) director of research, research laboratories, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., has been appointed to the research procedure committee of the Engineering Foundation.

Lysle W. Morton (A '38) electrical engineer with the General Electric Company, Schenectady, N. Y., has been appointed a member of the subcommittee on mercury-arc rectifiers of the American Standards Association.

Willard Champe (A '25, M '35) electrical engineer for the city of Toledo, Ohio, has been elected chairman of the AIEE Toledo Section. Mr. Champe was assistant editor of *Electrical Engineering* from 1931 to 1936.

E. H. Colpitts (A '11, F '12) retired vice-president of the Bell Telephone Laboratories, New York, N. Y., has been re-elected director of the Engineering Foundation.

J. S. Murray (A '21, M '31) chief electrical engineer for the Follansbee Steel Corporation, W. Va., has been elected national treasurer of the Association of Iron and Steel Engineers.

H. F. Dart (A '20, M '26) electronics tube engineering department, Westinghouse Electric and Manufacturing Company, Bloomfield, N. J., has been elected secretary of the Institute of Radio Engineers.

OBITUARY • • • •

William Slocum Barstow (A '94, F '12) retired president of Barstow, Tyng and Company, New York, N. Y., died on December 26, 1942. He was born on February 15, 1866 in Brooklyn, N. Y., and graduated from Columbia University with the degree of bachelor of arts in 1887. In 1935 he received an honorary degree of doctor of science from that university. He also possessed an honorary degree of doctor of engineering from Stevens Institute. He was employed by the Edison Machine Works in Schenectady, N. Y., Paterson, N. J., and New York, N. Y., from 1890 to 1897, when he joined the Edison Electric Illuminating Company in Brooklyn as assistant superintendent. He served as general superintendent and chief engineer of that company from 1890 to 1897 when he became general manager. In 1901 he left the Edison company to become an independent consulting engineer. In 1906 he established the firm, W. S. Barstow and Company, Inc., and became its first president. He organized the General Gas and Electric Corporation in 1912 and served as president until 1929. In that year he became president of Barstow, Tyng and Company. For many years he was officer of the Association of Edison Illuminating Companies, serving as secretary, treasurer, and a member of the executive committee. He was the author of a number of technical papers and held patents on such devices as a two-rate meter, clock switches, and a booster for storage batteries. He was a member of the United States Government Committe on the Super-Power System for the Eastern States and the jury of awards of the Pan-American Exposition at Buffalo, N. Y. From 1903 to 1905 he was vice-president of AIEE and a manager from 1900 to 1903. His other society affiliations included: founder and honorary president of the Edison Pioneers, trustee of Stevens Institute, president of the Thomas Alva Edison Foundation, member of the American Electro-Chemists Society, the Electrical Society, and the Illuminating Engineering Society. In addition he held the office of mayor of Kings Point village, Great Neck, N. Y., from 1924 to 1937. He was responsible for the erection of the Edison Tower at Menlo Park, N. J. (*EE, Nov. '42, p. 581*).

Nikola Tesla (A '88, F '17) electrical inventor, died on January 7, 1943. He was born in 1857 in Smitjan, Lika, Yugoslavia. He studied mathematics and physics at the Polytechnic School at Gratz, and philosophy at the University of Prague. In 1894 he received the honorary degrees of master of arts from Yale University and doctor of laws from Columbia University. He also held a degree of doctor of science from the Vienna Polytechnic Institute. Mr. Tesla began his career with the invention of a telephone repeater in 1881 in Budapest, Hungary. Later he did engineering work in Germany and France, coming in 1884 to the United States, of which he became a naturalized citizen. For a time he worked with Thomas A. Edison, chiefly designing motors and generators. Then he joined the Westinghouse company. In 1888 came his invention of the system of a-c power transmission which revolutionized industrial power transmission. Most of his other inventions, for which he held numerous patents, were made before 1900. He invented, in 1886, a system of arc lighting; in 1889, a system of electrical conversion and distribution by oscillatory discharges; in 1890, a generator of high-frequency currents; in 1891, a system of transmitting energy over a single wire without return, and the Tesla coil; in 1893, a system of wireless transmission; in 1894, a mechanical oscillator and generator of electrical oscillations; in 1897 a system of transmitting energy without wires, and a high-potential magnifying transmitter. Of late years he had been concerned principally with the possibilities of transmitting power without wires, particularly to ships at sea. AIEE presented the Edison medal to him in 1916 for "early original work in polyphase and high-frequency electric currents." For his contributions to science and engineering he was awarded the Order of the White Lion by Czechoslovakia. He served as AIEE vice-president from 1892 to 1894. He was also the recipient, in 1893, of the Elliott G. Cresson gold medal for original work presented before the Franklin Institute.

Carl G. Koppitz (M '21) vice-president and consulting engineer of the Railway and Industrial Engineering Company, Greensburg, Pa., died on January 6, 1943. Mr. Koppitz was born on January 10, 1878, at San Francisco, Calif. He began his career in 1896 as a powerhouse operator for the Electric Improvement Company, San Jose, Calif., and during 1898–99 worked as a lineman and foreman for the Phoenix Power Company, Tuolummie County, Calif. In 1900 he worked in France on the construction and operation of the Westinghouse exhibit in the Paris exposition. While in Paris he also had charge of the operation and construction of the Vitry and Bazon powerhouses of the Cie des Tramways de 1 Est Parisien and supervision of their substations. In 1902 and 1903 he was sales engineer for the Westinghouse Electric and Manufacturing Company in London and Birmingham, England. He was engaged in consulting engineering work as a partner in the firm, Sprout and Koppitz, San Francisco, Calif., during 1904. He worked as electrical engineer for the Youngstown Consolidated Gas and Electric Company and the Mahoning and Shenango Railway and Light Company from 1908 through 1911. Following a period of research in 1912, he was employed as a designer of powerhouses for the West Penn Power Company. He joined the Railway and Industrial Engineering Company in 1914 and was for many years chief engineer of that company. He was a member of the American Chemical Society and the American Association for the Advancement of Science.

Edwin Jay Prindle (A '06, M '20) retired patent attorney, died on December 17, 1942. He was born in Washington, D. C., on November 5, 1868, and received the degree of mechanical engineer from Lehigh University in 1890. He received from National University (later George Washington University) the degrees of bachelor of laws in 1902, and master of laws in 1904. He received the honorary degree of doctor of laws from that university in 1930 and that of doctor of engineering from Lehigh University in 1934. From 1890 to 1899 he worked as assistant examiner in the United States Patent Office. He practiced patent law in Washington until 1905, when he went to New York to carry on similar work involving electrical inventions. He was for some time senior partner in the patent law firm of Prindle, Bean, and Mann. He played a prominent part in educating the public to the value of the United States patent system and in securing reforms in the patent law. Author of a number of papers on patent law, he held several patents on inventions of his own. He was a past president of the New York Patent Law Association, and also served as chairman of the patent committees of the National Research Council and the National Association of Manufacturers. In addition he was a member of the American Society of Mechanical Engineers, American Institute of Mining and Metallurgical Engineers, American Chemical Society, American Electrochemical Society, and Tau Beta Pi.

Robert Michael Spurck (A '18, F '37) manager of sales, circuit breaker section, switchgear division, central station department, General Electric Company, Philadelphia, Pa., died on December 12, 1942. He was born at Nelson, Nebr., on July 2, 1888. Graduating in 1910 from the University of Illinois with the degree of bachelor of science in electrical engineering, he joined the General Electric Company, Schenectady, N. Y. In 1913 he received the degree of master of science from Union College. After working in the testing department of the General Electric company from 1910 to 1912, he was transferred to the switchgear engineering department. In 1914 he was placed in charge of the design and application of oil circuit breakers. Appointed assistant engineer in the switchgear department in 1925, he supervised engineering, development, design, testing, and application of switchgear apparatus. He was transferred to the company's Philadelphia works in 1928 as assistant engineer in charge of all apparatus design and engineering. In 1931 he was made assistant engineer, assisting in supervision, engineering development, and application of all apparatus manufactured in the Philadelphia works. He became manager of sales in 1935.

Fred Irvin Woltz (A '10, M '34) of the E. A. Wilcox Company, San Francisco, Calif., died on November 27, 1942. He was born on March 4, 1883 in Washington, D. C., and in 1909 graduated from Pennsylvania State College with a degree of bachelor of science in electrical engineering. In 1913 he received the degree of electrical engineer from that college. From 1909 to 1913 he worked on transformer and motor design in the engineering department of the Wagner Electric and Manufacturing Company, St. Louis, Mo. He did transmission-line studies and operation and construction supervision from 1913 to 1916 for the Idaho Power and Light Company, Twin Falls. Until 1918 he was power engineer for the Union Gas and Electric Company, Cincinnati, Ohio. From 1918 to 1925 he was in charge of power sales for the Central Hudson Gas and Electric Company, Poughkeepsie, N. Y. He later joined the engineering staff of the General Engineering and Management Company, New York, N. Y., where he was operating and construction assistant to the supervisor of middle western properties. In 1928 he became manager of industrial power service at the Metropolitan Edison Company, Easton, Pa. He had been employed by the Wilcox Company for about four years.

Alfred E. Seelig (A '07) president and general manager of the L. J. Wing Manufacturing Company, New York, N. Y., died on September 13, 1942. He was born on September 6, 1887, at New York, N. Y., and graduated from Columbia University with the degree of electrical engineer in 1907. He immediately entered the employ of the Electro Bleaching Gas Company, New York, N. Y., to work on the development of a new bleaching gas. In 1910 he became New England representative for the Wing company and in 1911, sales manager. Following a period as general manager of the Atlantic Communication Company in 1912, he became sales manager of the Kerr Turbine Company in Wellsville, N. Y. In 1917 he returned to the Wing company as president and general manager. He was also a member of the American Society of Mechanical Engineers and the American Society of Heating and Ventilating Engineers.

Lathorp Burtt Abeel (A '31) superintendent of stations for the Buffalo Niagara Electric Corporation, North Tonawanda, N. Y., died on October 20, 1942. He was born on July 29, 1883. He worked as operator and engineer for the Hudson Valley Railway Company from 1901 to 1907, when he was charged with handling new business and contracts. He joined the Burlington Light and Power Company as operator and engineer in 1913, and in 1916 joined the Consumers Power Company as engineer. In 1918 he became an operator for the Tonawanda Power Company (later merged with two other companies to become Buffalo Niagara Electric Company) and in 1933 he was made chief operator in charge of substations.

Charles J. Goldmark (A '88) retired consulting engineer, died on November 3, 1942. He was born in Brooklyn, N. Y., in 1867. He was graduated from Yale University where he studied mechanical engineering in 1887. He then took a course in electrical engineering at Cornell University from which he graduated in 1889. He was employed in the testing department of the Sprague Electrical Railroad and Motor Company, New York, N. Y., during 1888. As a consulting engineer, he specialized in the design and construction of railroad shops in the United States and Canada.

Claude Stratton Noble (A '18, M '29) transmission superintendent with the Tampa (Fla.) Electric Company died September 17, 1942. He was born in Salem, Oreg., on September 2, 1885, and attended the college of engineering of the University of Washington. From 1907 to 1910 he was employed by the Puget Sound Traction, Light and Power Company, Seattle, Wash., as station operator, and in 1910 became load dispatcher. He served as suburban district supervisor for the Puget Sound Light and Power Company from 1920 to 1926, when he became valley division superintendent. In 1926 he joined the Tampa Electric Company.

MEMBERSHIP • •

Recommended for Transfer

The board of examiners, at its meeting on January 21, 1943, recommended the following members for transfer to the grade of membership indicated. Any objection to these transfers should be filed at once with the national secretary.

To Grade of Fellow

Hopkins, R. A., head electrical engineer, Tennessee Valley Authority, Knoxville, Tenn.
Kinnard, I. F., executive engineer, General Electric Company, West Lynn, Mass.
Penniman, A. L., general superintendent, electrical operations, Consolidated Gas Electric Light and Power Company, Baltimore, Md.
Whitehurst, R., assistant general sales manager, The Electric Storage Battery Company, Philadelphia, Pa.
Wright, E. M., assistant engineer, Pacific Gas and Electric Company, San Francisco, Calif.

5 to grade of Fellow

To Grade of Member

Atwell, C. A., design engineer, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Broadwell, E. D., assistant professor of electrical engineering, Rensselaer Polytechnic Institute, Troy, N. Y.
Carter, G. K., electrical engineer, General Electric Company, Schenectady, N. Y.
Goss, J. H., engineer in charge, General Electric Company, West Lynn, Mass.
Holmes, L. C., assistant professor of electrical engineering, Rensselaer Polytechnic Institute, Troy, N. Y.
Iden, R. D., distribution superintendent, The Ohio Public Service Company, Mansfield, Ohio.
Jewell, R. G., development engineer, General Electric Company, Lynn, Mass.
Krazel, F. J., assistant chief engineer, shops, E. I. du Pont de Nemours Company, Pryor, Okla.
May, M., senior engineer, War Department, Corps of Engineers, St. Louis, Mo.
McCune, F. K., design engineer, General Electric Company, West Lynn, Mass.
McLean, C. R., superintendent, Mountain States Power Company, Albany, Oreg.
Osburn, O. R., professor, State College of Washington, Pullman, Wash.
Pulaski, S. S., experimental test engineer, Perfex Corporation, Milwaukee, Wis.
Rice, P. X., associate professor, Pennsylvania State College, State College, Pa.
Sims, W. B., assistant department head, Ebasco Services, Inc., New York, N. Y.
Sofiano, G. C., electrical engineer, The Electric Construction Company, Ltd., Birmingham, England.

Stein, L. B., assistant electrical engineer, United States Navy Department, New York, N. Y.
Stratford, F. F., toll testing engineer, Western Electric Company, Inc., New York, N. Y.
Tudbury, C. A., experimental engineer, The Ohio Crankshaft Company, Cleveland, Ohio.
VanDeusen, E. J., electrical design engineer, Mason and Hanger Company, Baraboo, Wis.
Westerkamp, P. R., commercial engineer in charge, Consolidated Edison Company of New York, N. Y.
Wilson, M. S., design engineer, General Electric Company, Lynn, Mass.
Winser, L., lieutenant commander, United States Naval Station, Manhattan Beach, Calif.
Yarmack, J. R., commercial engineer, Federal Telegraph and Radio Corporation, East Newark, N. J.

24 to grade of Member

Applications for Election

Applications have been received at headquarters from the following candidates for election to membership in the Institute. Names of applicants in the United States and Canada are arranged by geographical District. If the applicant has applied for direct admission to a grade higher than Associate, the grade follows immediately after the name. Any member objecting to the election of any of these candidates should so inform the national secretary before February 28, 1943, or April 30, 1943, if the applicant resides outside of the United States or Canada.

United States and Canada

1. North Eastern

Abbott, C. E., Signal Corps, Massachusetts Institute of Technology, Cambridge, Mass.
Albert, L. I., Colts Patent Firearms Manufacturing Company, Hartford, Conn.
Armstrong, I. W., Dinion Coil Company, Caledonia, N. Y.
Ayvasian, M. H. (Associate re-election), New England Power Service Company, Boston, Mass.
Bliss, P., New Britain Machine Company, New Britain, Conn.
Brockner, C. E., Union College, Schenectady, N. Y.
Butz, C. H., Sylvania Electric Products, Incorporated, Ipswich, Mass.
Chu, C. C., General Electric Company, Schenectady, N. Y.
Clarke, G. C., Jr., General Electric Company, Schenectady, N. Y.
Coullard, J. B., General Electric Company, Bridgeport, Conn.
Davis, R. V., General Electric Company, Pittsfield, Mass.
de Ferranti, M. A. (Member), Curtiss-Wright Corporation, Buffalo, N. Y.
DeLerno, M. J., General Electric Company, Schenectady, N. Y.
Dietze, T. W., General Electric Company, Lynn, Mass.
Dikmen, B. I., Manning, Maxwell and Moore, Bridgeport, Conn.
Dobbins, W. K. (Member), Seneca Vocational High School, Buffalo, N. Y.
Ellenburg, R. B., Radar School, Bowdoin College, Brunswick, Me.
Fleming, W. J., General Electric Company, Schenectady, N. Y.
Frisbie, G. W., 43 Arlington Street, Pittsfield, Mass.
Gaba, H. F., Signal Corps, U. S. Army, Electronics Training Center, Boston, Mass.
Gagne, J. W., General Electric Company, Schenectady, N. Y.
Greenleaf, F. D., South Street, Foxboro, Mass.
Harrell, B. F., Massachusetts Institute of Technology, Cambridge, Mass.
Hedlund, C. F. (Member), Associated Factory Mutual Fire Insurance Companies, Boston, Mass.
Hendricks, G. B., General Electric Company, Schenectady, N. Y.
Hertz, L. M., General Electric Company, Schenectady, N. Y.
Himes, B. T., Jr., U.S.N.R., Massachusetts Institute of Technology, Cambridge, Mass.
Jerrems, A. S., Massachusetts Institute of Technology, Radiation Laboratory, Cambridge, Mass.
Klug, K. W., United States Signal Corps, Austin Hall, Harvard University, Cambridge, Mass.
Kritscher, A. J., General Electric Company, Schenectady, N. Y.
Lodal, O. T. (Member), United States Engineer Office, Cooperstown, N. Y.
Lovewell, E. B. (Member), New Britain Machine Company, New Britain, Conn.
Massingill, J. A., General Electric Company, Schenectady, N. Y.
McEntire, K., General Electric Company, Schenectady, N. Y.
Moore, J. M. (Member), United Illuminating Company, New Haven, Conn.
Murchison, H. E., Simplex Wire and Cable Company, Cambridge, Mass.
Oberhelman, O. F., Jr., General Electric Company, Schenectady, N. Y.
Persson, J. A., Electrometallurgical Company, Niagara Falls, N. Y.
Pickard, J. K., General Electric Company, Schenectady, N. Y.
Pierson, E. T., General Electric Company, Bridgeport, Conn.
Poklepovic, D. P., General Electric Company, Schenectady, N. Y.
Ritchie, J. S., General Electric Company, Schenectady, N. Y.
Robinson, J. A., General Electric Company, Schenectady, N. Y.
Rudahl, A. E., Electrolux Corporation, Old Greenwich, Conn.
Ruibal, A., Union College, Schenectady, N. Y.
Swanson, M. C. (Associate re-election), American Locomotive Company, Schenectady, N. Y.
Sylvester, R. B., Lyndon Center, Vt.
Van Valkenburg, H. E., General Electric Company, Schenectady, N. Y.
Veronda, C. M., General Electric Company, Schenectady, N. Y.
Wardell, E. R., General Electric Company, Schenectady, N. Y.
West, C. F., Radiation Laboratories, Massachusetts Institute of Technology, Cambridge, Mass.
Williams, C. E., General Electric Company, Schenectady, N. Y.
Wilson, R. B., General Electric Company, Schenectady, N. Y.
Winkle, L., U.S.N.R., Massachusetts Institute of Technology, Cambridge, Mass.
Zimmele, E. M. (Associate re-election), Vought-Sikorsky Air Craft, Stratford, Conn.

2. Middle Eastern

Abramowitz, S., Philadelphia Signal Corps, Inspection Zone, Philadelphia, Pa.
Andreasen, I. E., General Electric Company, Erie, Pa.
Appleton, E. B., Naval Ordnance Laboratory, Washington, D. C.
Bass, P. B. (Member), Public Service Electric and Gas Company, Trenton, N. J.
Berger, H. J., American Telephone and Telegraph Company, Cleveland, Ohio.
Blashfield, W. H., North Electric Manufacturing Company, Galion, Ohio.
Boyer, J. L., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Bradshaw, F. C., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Brane, M. D. (Member), C. H. Hunt Company, Pittsburgh, Pa.
Brown, C. M., Jr., RCA Manufacturing Company, Inc., Camden, N. J.
Burke, J. T., Naval Research Laboratory, Washington, D. C.
Cham, E. J., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Chandler, H. M., Jr., Princeton University, Princeton, N. J.
Cherrick, I. L., Naval Research Laboratory, Bellevue, D. C.
Cooper, M. D. (Member), Fenn College, Cleveland, Ohio.
Cornelius, J. H., Brown and Heim, Inc., Baltimore, Md.
Cummins, S. M., 854 Rumsey Avenue, Erie, Pa.
Darr, J. E., Bethlehem Steel Company, Johnstown, Pa.
Davis, P. A. (Member), War Department, Signal Corps, Washington, D. C.
Deckelmann, L. M., Navy Dept., Bureau of Ships, Washington, D. C.
Douglas, G. R., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Eberstein, C. F., General Electric Company, Erie, Pa.
Edison, E., RCA Manufacturing Company, Camden, N. J.
Edmunds, W. H., I-T-E Circuit Breaker Company, Philadelphia, Pa.
Edwards, A. W., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Ellerman, H. E., Jr., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Ferdig, R. G., Navy Department, Bureau of Ships, Washington, D. C.
Ferris, F. H., Jr., Pennsylvania Transformer Company, Pittsburgh, Pa.
Foster, J. H., Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa.
Frandsen, L. N., Westinghouse Electric and Manufacturing Company, Baltimore, Md.
Gaubeca, J. B., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Godwin, G. L., Westinghouse Electric and Manufacturing Company, E. Pittsburgh, Pa.
Harden, H. B., Stone and Webster Engineering Corporation, Williamsport, Pa.
Harris, R., New Zealand Supply Mission, Washington, D. C.
Hellon, J. B., RCA Manufacturing Company, Camden, N. J.
Holzman, G. R., Naval Research Laboratory, Washington, D. C.
Hull, V. O. (Associate re-election), Line Material Company, Zanesville, Ohio.
Husbands, L. D., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Huttinger, F. X., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Isakson, F. B., Bureau of Ships, Navy Department, Washington, D. C.
Jaberg, H. A., Ohio Inspection Bureau, Cincinnati, Ohio.
Jenkins, J., Case School of Applied Science, Cleveland, Ohio.
Johnson, C. Y., U.S.N.R., Naval Research Laboratory, Anacostia Station, Washington, D. C.
Jones, R. C, Jr., Aircraft Radio Laboratory, Wright Field, Dayton, Ohio.
Jones, W. B., 3323 East Street, N. S., Pittsburgh, Pa.
Kelly, J. M., Jr., Naval Research Laboratory, Anacostia Station, Washington, D. C.
Kelso, F. (Associate re-election), Westinghouse Electric and Manufacturing Company, Philadelphia, Pa.
Kerr, N. F., Pennsylvania Transformer Company, Pittsburgh, Pa.
Ketch, W. E., Westinghouse Electric and Manufacturing Company, Wilkinsburgh, Pa.
Linton, R. L., Jr., Naval Research Laboratory, Anacostia Station, Washington, D. C.
McCabe, G. C. (Member), Potomac Electric Power Company, Washington, D. C.
McCleery, E. C., United States Engineers, Washington, D. C.
Meyer, C. F., Jr., General Electric Company, Erie, Pa.
Meyers, B. C. H., Consolidated Gas Electric Light and Power Company, Baltimore, Md.
Morgen, M., National Union Radio Corporation, Lansdale, Pa.
Moritz, C., Philco Radio and Television Corporation, Philadelphia, Pa.
Munnikhuysen, R. D., U. S. Army Air Forces, Materiel Center, Wright Field, Dayton, Ohio.
Niessink, T., University of Pittsburgh, Pittsburgh, Pa.
Opeka, F., Dravo Corporation, Pittsburgh, Pa.
Paden, G. O., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Panoff, R., United States Navy Department, Bureau of Ships, Washington, D. C.
Parchman, J. B., Sylvania Electric Products, Inc., Emporium, Pa.
Parrish, W. F., 2017 Edgewood Street, Baltimore, Md.
Paskevich, A. F., Pennsylvania Power and Light Company, Allentown, Pa.
Perkins, C. M., U. S. Army Air Corps, Wright Field, Dayton, Ohio.
Peters, R. R. (Member), United States Naval Reserve, Navy Yard, Philadelphia, Pa.
Possner, A. W., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Richmond, J. K., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Roccati, E. J., Chesapeake and Potomac Telephone Company, Washington, D. C.
Rough, L. W. (Associate re-election), Carbide and Carbon Chemicals Corporation, South Carleston, W. Va.
Rudnicki, A. J., U.S.N.R., c/o Crosley Corporation, Cincinnati, Ohio.
Rueggeberg, W., 408 Westgate Road, Baltimore, Md.
Sahm, P. A. B. (Member), Koppers Company, Pittsburgh, Pa.
Schneider, N., RCA Manufacturing Company, Camden, N. J.
Schoenberg, M. S., General Motors, Trenton, N. J.
Seaman, E. F. (Member), Bureau of Ships, Navy Department, Washington, D. C.
Shaffer, C. G., Western Electric Company, Baltimore, Md.
Shallcross, J. S., Shallcross Manufacturing Company, Collingsdale, Pa.
Shealy, A. N. (Member), Pennsylvania Water and Power Company, Baltimore, Md.
Smith, S. T., Naval Research Laboratory, Washington, D. C.
Stampley, N. L., Naval Research Laboratory, Washington, D. C.
Stoughton, M. L., I-T-E Circuit Breaker Company, Philadelphia, Pa.
Wahl, A., Air Corps, U. S. Army, Wright Field, Dayton, Ohio.
Warner, R. C., Consolidated Gas Electric Light and Power Company, Baltimore, Md.
West, K. L., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
White, R. A., Princeton University, Princeton, N. J.
Whitworth, D. G., Kelly Springfield Engineering Company, Cumberland, Md.
Wilcox, G. L., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.
Wilkinson, W. E., Consolidated Gas Electric Light and Power Company, Baltimore, Md.
Williams, C. R., Consolidated Gas Electric Light and Power Company, Baltimore, Md.
Woodhull, J. H., Federal Communications Commission, Washington, D. C.
Wouk, V., Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

3. New York City

Balchan, S. J., American Telephone and Telegraph Company, New York, N. Y.

Bartolotta, J. J., Signal Corps, Ft. Monmouth, N. J.
Bechtel, W. W., American Type Founders, Elizabeth, N. J.
Birsten, B. R., Solar Manufacturing Corporation, Bayonne, N. J.
Blincoe, L. R. (Associate re-election), General Electric Company, Newark, N. J.
Bolton, R. (Member), National Electric Company, Passaic, N. J.
Bloss, G. E., Long Island Lighting Company, Glenwood Landing, N. Y.
Cohen, P., War Department, Camp Evans, Belmar, N. J.
Davis, C. M., Postal Telegraph-Cable Company, New York, N. Y.
Duffy, E. K., General Cable Company, Bayonne, N. J.
Duguid, D. S., Bell Telephone Laboratories, Incorporated, New York, N. Y.
Dunlop, J. N., Jr., 122 East 82d St., New York, N. Y.
Friedman, E. D., Federal Telephone and Radio Corporation, Newark, N. J.
Furlong, J. F., Jr., Western Electric Company, New York, N. Y.
Gilmore, G. E., USS Prairie State, New York, N. Y.
Hayman, W. H., Press Wireless, Incorporated, Hicksville, N. Y.
Horn, H. H., Arma Corporation, Brooklyn, N. Y.
Joy, C. R., Jr., Signal Corps, Ft. Monmouth, N. J.
Kelly, F. G. (Member), Thomas A. Edison, Incorporated, West Orange, N. J.
Konigsberg, R. L., Western Electric Company, Kearny, N. J.
Kors, S. M., American Telephone and Telegraph Company, New York, N. Y.
Martin, M., Lone Star Steel Company, New York, N. Y.
McClenahen, R. A. (Member re-election), Public Service Electric and Gas Company, Newark, N. J.
Moulton, W. H., National Union Radio Corporation, Newark, N. J.
Ostrolenk, S., 10 East 40th Street, New York, N. Y.
Paterson, G. H. (Member), War Department, New York Ordnance District, New York, N. Y.
Peskin, E., Polytechnic Institute of Brooklyn, Brooklyn, N. Y.
Platt, C. J., Wilputte Coke Oven Corporation, New York, N. Y.
Sanderson, C. M., Jr., 324 Meadowbrook Lane, So. Orange, N. J.
Sanial, A. J. (Member), Powers Electronic and Communication Company, Glen Cove, N. Y.
Seels, H. F. (Associate re-election), Sperry Gyroscope Company, Incorporated, Brooklyn, N. Y.
Selgin, P. J., Polytechnic Institute of Brooklyn, Brooklyn, N. Y.
Simmonds, R. L., Signal Corps, U. S. Army, Fort Monmouth, N. J.
Stamatov, G. (Associate re-election), Consolidated Edison Company, New York, N. Y.
Struven, D. J. (Associate re-election), Westinghouse Lamp Division, Bloomfield, N. J.
Waldron, J. E., Nicaro Nickel Company, New York, N. Y.
Weiller, P. G., Square D Company, Woodside, L. I., N. Y.
Wheeler, R. B., 36 Catalpa Avenue, Hackensack, N. J.
Wilkie, A. C., Jr., 490 Port Washington Blvd., Port Washington, N. Y.
Woods, R. J., Sperry Gyroscope Company, Incorporated, Brooklyn, N. Y.
Woodworth, J. D., Signal Corps General Development Laboratory, Fort Monmouth, Red Bank, N. J.
Wright, F. E. (Associate re-election), 30 Church Street, New York, N. Y.
Yeager, J. R., American Telephone and Telegraph Company, New York, N. Y.
Yoe, H. A. (Member re-election), Bendix Aviation Corporation, Brooklyn, N. Y.

4. Southern

Brauneck, C. F., Signal Corps, Camp Murphy, Fla.
Buck, J. R., U. S. Navy Department, Pascagoula, Miss.
Chatham, O. L., U.S.E.D., Tampa, Fla.
Cooke, S., U. S. Army Air Corps, Communications Detachment, Tuskegee, Ala.
Cross, J. W., Memphis Light Gas and Water Division, Memphis, Tenn.
Duncan, W. A., Kentucky Utilities Company, Lexington, Ky.
Egee, J. W. (Associate re-election), Bull Dog Electric Products Company, New Orleans, La.
Evans, T. P., Hercules Powder Company, Radford, Va.
Funderburk, M. M., Louisiana Power and Light Company, Sterlington, La.
Gardberg, J., Gulf Shipbuilding Corporation, Chickasaw, Ala.
Hite, J. L., Kentucky Utilities Company, Lexington, Ky.
Jennings, H. F., Tennessee Valley Authority, Knoxville, Tenn.
Kerr, W., Jr., University of Tennessee, Knoxville, Tenn.
Newby, D. H., National Advisory Committee for Aeronautics, Langley Field, Va.
Patrick, W. A., General Electric Supply Corporation, Louisville, Ky.
Smith, E. A., U. S. Army, Ordnance Department, Ft. Myers, Fla.
Sprouse, M. N., Tennessee Valley Authority, Knoxville, Tenn.
Strode, V. C., Jr., Signal Corps, Air Force, Tampa, Fla.
Stuart, B. B. (Member), Navy Department, Navy Yard, Charleston, S. C.
Thomas, G. S., United States Navy Yard, Charleston, S. C.
Waite, C. T., Jr., Army Air Corps, Barksdale Field, La.
Westermeyer, C. H., 118th Signal Radio Intelligence Co., Camp Forrest, Tenn.

5. Great Lakes

Abramson, J. E., Allis-Chalmers Manufacturing Company, Milwaukee, Wis.
Andes, S. I., Lake Machinery Company, Chicago, Ill.
Carpenter, H. A., 512 West South Street, Angola, Ind.
Davidson, C. P., RCA Victor Division, Radio Corporation of America, Indianapolis, Ind.
Ellis, H. N., 246 Waubesa Street, Madison, Wis.
Flaugh, F. C., Jr., Chicago Signal Corps Inspection Zone, Chicago, Ill.
Healy, C. F., 208 West Lyon Street, Marshall, Minn.
Kumm, E. L., Dow Chemical Company, Midland, Mich.
Larson, C. J. (Associate re-election), Commonwealth Edison Company, Chicago, Ill.
Larson, L. R., Iowa State College, Ames, Iowa.
Marchant, T. E., 801 Jefferson Street, Gary, Ind.
Michals, R. J., Minneapolis-Honeywell Regulator Company, Minneapolis, Minn.
Mortley, J. T., Ford Motor Company, Dearborn, Mich.
Naylor, M. W., 338 West 30 Street, Davenport, Iowa.
Petermann, F. C., U. S. Signal Corps, Electronics Division, University of Chicago, Chicago, Ill.
Pinsky, J. D., Museum of Science and Industry, Chicago, Ill.
Polcyn, S. J., Jr., Allis-Chalmers Manufacturing Company, West Allis, Wis.
Reese, K. E., Zenith Radio Corporation, Chicago, Ill.
Reilly, E. L. (Associate re-election), U. S. Maritime Commission, Chicago, Ill.
Schaller, W. F. (Member), Marquette Electric Switchboard Company, Chicago, Ill.
Schneider, C. L., Ordinance Steel Foundry Company, Betendorf, Iowa.
Staats, G. W., Allis-Chalmers Manufacturing Company, Milwaukee, Wis.
Standish, M. E., Carnegie-Illinois Steel Corporation, Chicago, Ill.
Thomas, J. H., 1135 Robertson Street, Wawuatosa, Wis.
Whitehead, L. E. (Associate re-election), Commonwealth Edison Company, Chicago, Ill.
Willson, E. A. (Associate re-election), Northern States Power Company, Minneapolis, Minn.
Yates, R. E., Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

6. North Central

Nitta, R. Y., Del Norte, Colo.
Tarr, A. B., Colorado Central Power Company, Englewood, Colo.
Winslow, W. M., Public Service Company of Colorado, Denver, Colo.
Yewell, P. G., U. S. War Department, Fowler, Colo.

7. South West

Adams, P. E., Jr., Signal Corps, U. S. Army, Fort Sill, Okla.
Blanchette, V. G., Consolidated Steel Corporation, Ltd., Orange, Tex.
Carson, L. M., Dennis, Kan.
Curry, E. M., Southwestern Bell Telephone Company, Oklahoma City, Okla.
Haas, P. A. (Associate re-election), Board of Public Utilities, Kansas City, Kan.
Howell, A. L., Consolidated Steel Corporation, Ltd., Orange, Tex.
Moder, E. C., Jr., Rural Electrification Administration, St. Louis, Mo.
Money, L. J., Rice Institute, Houston, Tex.
Palmer, J. P., 2152 Watts Road, Houston, Tex.
Robinson, F. H. (Member), Rural Electrification Administration, St. Louis, Mo.
Shepherd, N. H., Box 726, Altus, Okla.
Staff, V. E. (Member), Naval Ammunition Depot, McAlester, Okla.
Sumner, G. C., 315 Chicago Street, Fort Worth, Tex.
Vreeland, W. N., Jr., Thomas A. Edison, Incorporated, St. Louis, Mo.
Watkins, B. O., Rural Electrification Administration, St. Louis, Mo.
Westheimer, E. G., Southwestern Bell Telephone Company, Houston, Tex.
Woolsey, D. L., Signal Corps, Camp Crowder, Mo.

8. Pacific

Ardery, J. E., Consolidated Aircraft Corporation, San Diego, Calif.
Bales, W. L., 208—23rd Avenue, San Mateo, Calif.
Bulkley, O. R. (Associate re-election), Southern California Edison Company, Limited, Los Angeles, Calif.
Caldwell, F. R., 1617 N. Dayton Street, Phoenix, Ariz.
Chang, T. C., W. A. Bechtel Company, Sausalito, Calif.
Doolittle, O. L., Southern California Telephone Company, San Diego, Calif.
Edward, A. W., R.N.V.R., British Admiralty, British Ministry of War Transport, San Francisco, Calif.
Enefer, J. D., Southern California Edison Company, Limited, Los Angeles, Calif.
Fleager, W. M., Pacific Telephone and Telegraph Company, Oakland, Calif.
Geisendorfer, H. A., Jr., Richmond Shipyard No. 1, Richmond, Calif.
Gerckens, C. H., Cole Electric Company, Los Angeles, Calif.
Goetz, J. A., Jr., N.A.C.A., Ames Aeronautical Laboratories, Moffett Field, Calif.
Hoffman, O. W., General Electric Company, Oakland, Calif.
Kaprielian, E. F., U. S. Navy, Terminal Island, Calif.
Moeller, R. A., Taypro Corporation, San Francisco, Calif.
Nahapiet, E. O. (Associate re-election), Austin W. Earl, San Francisco, Calif.
Proppe, H. L., Jr., Westinghouse X-Ray Division, San Francisco, Calif.
Read, R. F., Sundt Construction Company, Tucson, Ariz.
Richey, R. R., Westinghouse Electric and Manufacturing Company, San Diego, Calif.
Rutherford, C. E., Lockheed Aircraft Corporation, Burbank, Calif.
Samter, J. H., Dow Chemical Company, Pittsburg, Calif.
Stewart, R. R. (Associate re-election), Joslyn and Ryan, San Francisco, Calif.
Syron, R. O., Signal Corps, Service Command, c/o Postmaster, San Francisco, Calif.
Talbott, W. H., Jr., Westinghouse Electric and Manufacturing Company, Los Angeles, Calif.
Veit, W. A., 819 No. Olive Avenue, Alhambra, Calif.
Walsh, W. C. (Associate re-election), United States Department of Agriculture, Farm Security Administration, San Francisco, Calif.
West, G. P., P.O. Box 152, Sunol, Calif.
Wilson, G. A., Barrett and Hilp, Hunters Point Drydocks, San Francisco, Calif.

9. North West

Ashleman, F. C., 18th Coast Artillery, Fort Stevens, Oreg.
Bodine, F. E., Westinghouse Electric and Manufacturing Company, Salt Lake City, Utah.
Bruce, E. C., 845 Engr. Avn. Bn., Geiger Field, Spokane, Wash.
Fincher, E. H., Westinghouse Electric and Manufacturing Company, Seattle, Wash.
Greiling, R. D., 7542 North Commercial Avenue, Portland, Oreg.
Lindberg, B. G., 1823 South Grand Boulevard, Spokane, Wash.
Mackenzie, N. (Member), Colville Engineering Company, Colville, Wash.
McDowell, J. M., Signal Corps-Reserve, U. S. Army, Seattle, Wash.
McGill, C. S. (Member), Montgomery Electric Company, Portland, Oreg.
Purcell, J. L. A. (Member), United States Engineer Office, War Department, Seattle, Wash.
Retherford, R. W., Naval Training School, University of Idaho, Moscow, Idaho.

10. Canada

Bailey, F. G., Bell Telephone Company, Toronto, Ont.
Bradfield, A W., Canadian General Electric Company, Ltd., Peterborough, Ont.
Comach, S. I. (Member), Royal Canadian Navy, Ottawa, Ontario, Canada.
Fisher, S. T. (Member), Northern Electric Company, Ltd., Montreal, Quebec.
Kidd, K. H., Royal Canadian Engineers, Canadian Army, Brockville, Canada.
Lillie, B. A., Hydro Electric Power Commission o Ontario, Toronto, Ont.
MacDonald, W. P. (Member), Nanaimo-Duncan Utilities, Ltd., Nanaimo, B. C.
Mitchell, D. A., Hydro-Electric Power Commission, Burlington, Ont.
Schofield, L., Canadian Westinghouse Company, Limited, Montreal, Quebec.
Southam, W. W., Vancouver Daily Province, Vancouver, B. C., Canada.
Tallman, A. M., English Electric Company, St. Catharines, Ont.

Total, United States and Canada, 311

Elsewhere

Bird, F. V. G. (Member), Central Electricity Board, London, W.C. 2, England.
Bryant, A. C. (Member), Messrs. Johnson and Phillips Limited, London, S.E. 7, England.
Cory, F. P., Painton and Company Limited, Northampton, England.
Gonzalez, E. F. A., Cristo, Ote., Cuba.
Grobler, P. S. (Associate re-election), Provincial Administration, O.F.S., Kroonstad, South Africa.
Meneses, R., Compania Mexicana de Luz y Fuerza, Juarez, Mexico.
Zifl, M. L., Johnson and Phillips Limited, Victoria Way, Charlton, S.E. 7, London, England.

Total, elsewhere, 7

Royal Electrical and Mechanical Engineers Corps Established by British Army

Electrical and mechanical engineering maintenance for the British Army has been brought under single control by the formation of the Royal Electrical and Mechanical Engineers. The unit is described in the ensuing news item which was prepared for publication in *Electrical Engineering* by Owen Pawsey, former editor of *Electrical Trading* and former member of the editorial staff of *Broadcaster*, both British periodicals.

This new corps, which came into being officially on October 1, 1942, is the complete engineering-maintenance wing of the British land forces, with the exception of civil engineering. Functions of the corps are:

1. The inspection and maintenance of tanks, wheeled vehicles, all artillery (including field, antiaircraft, and coast defense), small arms and machine guns, radio and line communication equipment, radiolocation (radar), fire control and other instruments, tunneling equipment, pumping sets, and the installation of coast-artillery machinery.

2. Repairs made necessary by ordinary wear and tear or battle casualties.

3. Investigations into defects in design and recommendations for improvements.

4. Advice on prototype design in relation to maintenance work.

NEW CORPS AIDS EFFICIENCY

Prior to the formation of the REME, responsibility for engineering maintenance and repairs was split up. The bulk of the work previously was under the control of the Royal Army Ordnance Corps, but there were also large technical sections in the Royal Engineers and the Royal Army Service Corps, and further smaller groups of skilled engineers elsewhere. One result of this spread-out setup was a lack of unified direction on technical maintenance at the British War Office.

Each unit had evolved its separate control and methods for engineering maintenance, and as these were administered alongside many other matters completely unrelated to engineering, the channels of control frequently included nontechnical personnel. This sometimes resulted in delay and distortion of technical matters the importance of which had not been appreciated or understood fully.

Further disadvantages were that the equipment used for testing and repair had to be well dispersed among the various Army units, and skilled tradesmen were not always employed fully in those duties for which they were qualified.

These disadvantages have been rectified in the REME organization, which combines the necessary centralized control with a fluid system providing quick and efficient maintenance for all electrical and mechanical equipment. The nucleus of the corps consists of the technical sections of the Royal Army Ordnance Corps, Royal Engineers, and Royal Army Service Corps already mentioned. At an early date appropriate personnel of the Royal Artillery, Royal Armored Corps, and Royal Signals are also to be incorporated.

Major General Eric Bertram Rowcroft, an engineer of wide civil and military experience, controls the REME from the War Office, where there is direct and equal representation of all technical matters. From him extends a complete chain of coordination of engineering personnel passing down through deputy directors to the electrical and mechanical engineer, who acts as technical adviser to the brigade commander in the field. This system ensures that on matters of general strategy, tactics, and operations there are REME experts at all stages to see that engineering technical equipment and personnel are adequately provided and employed.

Alongside this "policy channel," the REME has its own direct approach to and from the headquarters staff of the War Office on all domestic questions. Although attached to every unit in the Army which uses mechanical or scientific equipment the REME is autonomous in the control of its men and this latter channel is employed for that purpose. It also ensures that maintenance procedure is transmitted quickly and efficiently and that any questions that may arise on purely technical affairs are brought to the notice of higher officials who are able to understand them, value them properly, and obtain decisions with the least possible delay.

A further function of this channel is to give officers and men of the new corps a voice in prototype design. Such advice is confined to engineering maintenance and the study of related defects of equipment, although, of course, full design is encouraged in the case of equipment needed in the course of testing, repairing or inspecting of army gear.

British Ministry of Information

Radio mechanics of the Royal Electrical and Mechanical Engineers service British Army apparatus at a base workshop

SPECIALIZATION

To permit full specialization the corps is divided into several branches. On the electrical side there are three branches: first, "telecommunications," an omnibus word adopted to cover radar, radio, and wire; second, there is the light electrical section which has the care of the Army instruments and specialized equipment such as searchlights; third, the heavy electrical section, which corresponds to power engineering in civil life. Automobile electricity is the responsibility of the vehicle branches (armored fighting vehicles and transports).

Whereas specialization is an advantage in the upper strata of the corps and among the mechanics and engineers in the noncommissioned ranks, it is unnecessary and

even inadvisable in the lower commissioned ranks. Officers who have charge of men actually in the combat zone are required to have general knowledge both of electrical and mechanical engineering and all their training is planned with that in view.

At present men having the requisite qualifications to obtain direct entry into the corps are scarce. British industry already has had to give up all its qualified technical men below the age of 25 years.

NONCOMMISSIONED RANKS

As in the case of officers, so in the case of noncommissioned ranks, the REME has adopted a full scheme of college and field training, which in present circumstances is condensed into a period of nine months. The course for commissioned ranks corresponds to normal "continuation" classes; it assumes a fundamental practical knowledge of electricity, mechanics, or electronics and instructs in particular applications to warfare.

Wherever possible the noncommissioned ranks are drawn from men who already have had experience as electricians, radio service mechanics, power linesmen, and similar occupations, and such men have opportunities to obtain immediate rank as sergeant-artificer on finishing their army course. The "private", known in the REME by the new rank of craftsman, is mostly recruited from inexperienced men who show an interest in mechanical or electrical work. The rates of pay throughout the corps are generally on a higher scale than those of the other Army units.

Parker Dam Begins Operation in Southwest

The newest large Bureau of Reclamation hydroelectric power plant, the Parker Dam plant in California–Arizona on the Colorado River, has begun generating power and will be operating at maximum capacity of 120,000 kw by next May, ten years ahead of the originally scheduled time, according to a recent announcement. This is the 29th hydroelectric development placed in operation by the Bureau in 40 years.

This new plant, which is supplying energy for war industry, mining operations, and military use in the Pacific Southwest, already has three 30,000-kw generators completed, two of which started commercial operation in December, and one scheduled to begin later; the fourth generator is expected to begin operation in May.

Parker Dam has as a primary purpose the diversion of water from the Colorado River for the Metropolitan Water District of Southern California, a group of 13 cities in the Los Angeles metropolitan area. The Metropolitan Water District financed the construction of Parker dam, and is entitled when it requires the power, to one half of the output from the power plant. Total maximum available output is quoted as 600,000,000 kilowatt-hours of electric energy annually. Title to the dam is in the United States.

Horsepower of Electric Motors Restricted by WPB

The horsepower of a new electric motor may not exceed the requirements of the specific job for which the motor is purchased, according to a recent provision in the War Production Board general conservation order L-221.

To prohibit the former industrial practice of applying greater motor capacity than necessary for the job to be done, the order prohibits the delivery or acceptance of motors, unless they comply with certain standard specifications and are of the simplest practicable mechanical and electrical design. It also requires the purchaser to certify and show reason why he must have a motor of a special type; and it restricts the use of such special types to the conditions and the purposes for which they are required. For example, it limits the use of explosionproof motors to hazardous locations.

One of the important conservation provisions in the order, which applies to both motors and generators, requires the applicant to certify that he has made every reasonable effort

1. To adapt idle motors or generators in his possession.
2. To obtain used ones for his purpose.
3. To repair or recondition his existing equipment.

If one cannot secure used equipment within a reasonable time, one may apply to the WPB Surplus Used Equipment Branch for assistance.

The order is expected to save annually about 15,000,000 pounds of copper, 55,000 tons of carbon steel, and 150,000 pounds of stainless steel.

The Navy Needs Engineers for Electronic Work

The United States Navy Department recently issued the following request for engineering personnel:

"The rapid expansion in Navy surface vessels, submarines, and aircraft has created several hundred additional billets for officers trained in electrical engineering who are needed to serve in engineering work in connection with ultrahigh-frequency electronic apparatus, the Navy announced recently.

"The Navy has issued a call for qualified engineers to fill the new vacancies. Technically qualified for this work are men who hold degrees in electrical engineering and have practiced in the field of engineering since their graduation; or men who have majored in physics, mathematics, or other branches of engineering and who have acquired a sound working knowledge of a-c circuits and electronics.

"Men commissioned for this electronic work are given the Navy's three-months' course in ultrahigh frequencies at either Harvard University or Bowdoin College, followed by an additional three-months' laboratory course at Massachusetts Institute of Technology. Upon graduation, these officers are assigned to responsible engineering positions having to do with research, design, instruction, or maintenance of the Navy's ultrahigh-frequency equipment.

"Qualified engineers are urged to apply for a commission at the nearest Office of Naval Officer Procurement. These offices are located in principal cities throughout the United States."

TVA Reports Progress During Past Year

Tennessee Valley Authority began construction of eight dams for war production of power, continued work on three % dams on shortened wartime schedules, and started operation on four dams and a large steam plant during the fiscal year, according to the annual report to the President and Congress. About 500 miles of transmission lines were built, increasing the network by ten per cent, and a major interconnection with power systems to the north was effected, making possible more efficient use of power facilities in the TVA and adjoining areas.

A large ammonium nitrate plant, with a newly constructed synthetic ammonia plant to supply raw materials, was placed in service to produce an ingredient of high explosives for the War Department. Another plant used in peacetime for production of phosphatic fertilizers was enlarged and equipped to produce elemental phosphorus for the Chemical Warfare Service. TVA now has one fourth of the Nation's capacity for production of munitions-grade phosphorus.

Completion of dams during the year brought the navigation channel on the Tennessee to four fifths of its ultimate 650-mile length, and flood control storage in the Authority's reservoirs was increased to 6,000,000 acre-feet, an increase of 2,000,000 acre-feet.

Slide-Films for First Aid Issued. First-aid slide-film kits designed to assist in first-aid training programs conducted on a company-wide scale are now available. The film-strip kit includes 20 individual slide-film subjects (averaging 70 individual pictures each) in technicolor; 14 records containing 20 correlated voiced lectures to be used with the films; 20 printed lesson guides for student study, and an instructor's manual showing how to conduct the classes. Although it is not intended that the slide-film kit alone should train the class completely, but rather add to lecture, textbook, and demonstration, the use of the kit makes it possible to conduct an approved and official course in less time than is required ordinarily by lecture, demonstration, and textbook alone. The film strips may be projected in any slide-film projector equipped with a record turntable. All inquiries should be addressed to the distributors, the Jam Handy Organization, 2900 East Grand Boulevard, Detroit, Mich.

Armor Rod Patents Given to Public. Patents for armor rods, previously employed chiefly with a single type of transmission-line cable, recently were made available to the public for all conceivable uses and without the need for licensing procedure, when a deed of public dedication was filed by Aluminum Company of America in the United States Patent Office, Washington, D. C. The patents made available to the public are numbers 1,639,820 and 1,873,798. Armor rods resemble an extra layer of heavy strands and are used to cover the cable for a short distance at points of support.

INDUSTRY • • • • •

Graduate Evening Courses Being Given in Industrial Plant

Graduate evening extension courses in advanced electronics, electromagnetic-wave theory, and ultrahigh-frequency phenomena are being conducted at the Garden City plant of the Sperry Corporation by staff members of the department of graduate study and research in electrical engineering, Brooklyn Polytechnic Institute.

Courses currently being conducted by the school at Garden City include: Advanced-circuit theory by Ernst Weber (F '34), head of the graduate electrical engineering department; fundamentals of radio by William A. Lynch (sponsored by the government Engineering, Science, and Management War Training program); and two other ESMWT courses under the direction of George B. Hoadley (M '41). Specific applications of the theories to the day-to-day work at the plant are taught by Henry Harris of the Sperry Corporation under the direction of Ralph Carlson, director of employe training at the Garden City plant.

Positions to Be Filled Through Civil Service

The United States Civil Service Commission is accepting applications for the following engineering positions until further notice. Because of the urgent need for engineers, written tests and age limits have been abandoned for these positions. Applicants will be judged on education and experience. Applications and complete information may be obtained at any first- or second-class post office, except in regional headquarters cities, where they are available, only at the civil service regional office, or from the United States Civil Service Commission, Washington, D. C. War man-power restrictions on Federal appointments are also posted in first- and second-class post offices. Vacancies in Washington, D. C., throughout the United States, and in the territories and possessions of the United States are to be filled.

Assistant Engineer ($2,600 a year salary) through *chief engineer* ($8,000 a year salary). This position requires the completion of a full four-year course leading to a bachelor's degree in engineering in a college or university of recognized standing. Professional engineering experience providing the substantial equivalent of such a course may be substituted for the foregoing educational requirement. In addition one year of professional engineering experience or of engineering graduate study is required for the position of assistant engineer at $2,600. For more advanced positions, applicants must show additional experience of a progressively higher level.

Junior engineer ($2,000 a year salary). No experience is necessary. College graduates with a degree in any field, who are enrolled or willing to enroll in the Engineering, Science, and Management War Training Course in engineering fundamentals, sponsored by the United States Office of Education, may apply.

Radio inspectors ($2,600 and $2,000 a year salaries.) Needed for employment in the Federal Communications Commission. Study at a college or university of recognized standing, technical experience in radio work, or a combination of the two will be accepted as preparation for these positions. Amateur radio experience under a class *A* license may be substituted as part of the experience requirement. In addition, applicants must hold a valid second-class radiotelegraph operator's license, or demonstrate their ability to transmit and receive 16 code groups per minute in International Morse Code, and be able to drive an automobile.

Westinghouse Fellowships Suspended. Ten research fellowships, awarded annually by the Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa., have been discontinued until after the war. The fellowships were established in 1937 for research in physics, making possible a study of the scientific problems confronting the electrical industry. The company plans to continue only that research directed toward aiding the war effort. However, it has been announced that the company is interested in employing men who normally would be eligible for the fellowships, thereby enabling young scientists more quickly to find a place in the war activities now under way.

OTHER SOCIETIES •

AIME Lucas Medal Awarded

The Anthony F. Lucas Gold Medal for 1943 of the American Institute of Mining and Metallurgical Engineers has been awarded to John Robert Suman, vice-president of the Humble Oil and Refining Company, Houston, Tex., for his "distinguished achievement in improving the technique and practice of producing petroleum." The oil-producing research carried on under Doctor Suman's direction is said to have revolutionized production methods and to have established oil-reservoir engineering on a sound foundation. It is estimated that the efficiencies and the economies made possible by this research have cut oil-producing costs almost in two and have doubled the proportion of recoverable oil.

Doctor Suman was born in Daleville, Ind., on April 9, 1890, and was graduated from the School of Mines, University of California, Berkeley in 1912. Almost his entire professional work has been in the oil-producing industry.

Future Meetings of Other Societies

American Institute of Mining and Metallurgical Engineers. Annual meeting, February 14–18, 1943, New York, N. Y.

American Railway Engineering Association. Annual Convention, March 16–18, 1943, Chicago, Ill.

American Society for Testing Materials. Spring meeting, March 2–5, 1943, Buffalo, N. Y.; annual meeting, June 28–July 2, 1943, Pittsburgh, Pa.

Engineering Institute of Canada. 57th annual meeting, February 11–12, 1943, Royal York Hotel, Toronto, Canada.

National Electrical Manufacturers Association. Spring meeting, April 20–23, 1943, Chicago, Ill.

Melville Medal Award Announced. The Melville Medal, awarded annually by American Society of Mechanical Engineers for the most original paper on a mechanical-engineering subject, has been presented to J. Kenneth Salisbury, of the turbine engineering department of the General Electric Company, Schenectady, N. Y., for his paper, "The Steam Turbine Regenerative Cycle—an Analytical Approach." Mr. Salisbury received the degrees of bachelor of science in 1929 and master of science in mechanical engineering in 1930 from the University of Michigan. He has been employed by the General Electric Company since 1930.

New Sections Formed by NEMA. The formation of an electronics section and an industrial and commercial lighting equipment section has been announced by the National Electrical Manufacturers Association. The electronics section will seek to establish a maximum use of the electronic science in winning the war and in rebuilding the world after the war. The commercial lighting section will try to effect the fullest and best employment of lighting in the war effort.

EDUCATION • • •

Northwestern's Technological School Receives Liberal Bequest

A bequest in excess of $20,000,000 to be used as a fund to develop, maintain, and operate its technological institute will be given to Northwestern University from the estate of Walter P. Murphy, manufacturer of railway supplies, who died December 16, 1942. The university will receive the entire estate after payment of bequests to relatives and friends.

The technological institute of Northwestern University was founded in 1939 by a gift of $6,735,000 from the Walter P. Murphy Foundation. Mr. Murphy had made two additional gifts to this university, $5,000 to the college of liberal arts and $10,000 to the school of commerce in 1923.

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without letter, the other lettered. Captions should be supplied for all illustrations.

Detecting the Saboteur—Static Electricity—in Gasoline Fires

To the Editor:

Questions regarding hazards due to static electricity are continually arising in industry. The choice of a "cure" is sometimes either ineffective or in some cases more hazardous than the condition existing before application of the "cure."

Studies have been made of static generation and its removal in some types of industrial operations. In many cases such studies have been sufficiently broad to find direct application in other fields. In many cases, however, the best solutions for the problems have not been published.

Do you think this subject could be handled by the Institute as a seminar at one of the meetings? Could the Institute be prevailed upon to prepare a critical study and bibliography of the published articles? Such a subject should be very timely considering the hazards associated with operations carried on in wartime.

In this regard, we read with interest the article, "Detecting the Saboteur—Static Electricity—in Gasoline Fires," by Robin Beach in the October 1942 issue of *Electrical Engineering*, pages 501–8.

In this article there is one point that forms the basis of the solution of the author's first case but does not appear to be valid.

In Figure 1 he shows the tank as one capacitance and the tank truck as a capacitance in series with a second capacitance comprising the surface of the roadway as an equipotential surface and the base of the roadway at ground potential as the second plate of the series-capacitance combination.

The resistance of the roadway tires is high, so that in effect it appears that the tank truck to ground could be treated as a single capacitance.

If this were the case, the tank could be brought to the potential of the truck practically instantly when the grounding wire from the truck was connected to the tank. This would, of course, reduce the voltage to ground of the truck by virtue of charging the tank which is assumed to be 500 micro-microfarads. If the truck is 1000 micro-microfarads, the potential of the truck to ground would be two thirds the initial voltage of the truck.

This, admittedly, is the extreme case, opposite to that taken by the author, which would give rise to a voltage in excess of the 2,000 value in a few microseconds.

If the capacitance of the truck to ground in the equivalent circuit given in Figure 1 can be considered as two series capacitances, that is, the capacitance of the truck to the roadway surface, which must be regarded as a conductive layer, and the roadbed as the dielectric of the second capacitance, this will reduce the effective capacity of the tank truck to ground according to the values of the series capacitances.

Here, in effect, would be three capacitances in series. After the grounding wire is connected, the potential on each capacitance would be inversely proportional to the value of the capacitance. If the capacitance of the element comprising the tires, roadbed, and so forth, is shunted by a resistor representing the leakage resistance, it then appears that the potential to ground on the tank would reach an initial maximum value when the tank is connected to the truck and would probably decrease as the current leaks off the roadway surface to the true ground instead of rising as indicated in Figure 2.

It appears evident to the writer that the curve in Figure 2 should start with the initial voltage on the tank as being the equilibrium value immediately after the ground wire is connected to the tank. Here the voltage would be equal to the voltage of the combined drops across the truck to roadway and the roadway to ground. The logarithmic rise or fall in potential of the tank to ground would depend on the assumptions made of the role played by the roadway as series capacitances. At any rate, the change in voltage to ground of the tank would be slight and would probably decrease instead of increase.

If the breakdown voltage of the insulation on the tank were 2,000 volts, is it not possible that initial breakdowns occurred without igniting the gasoline vapors? As the vapors were expelled from the vent pipe a flammable mixture could have accumulated gradually near the ground that was ignited by a subsequent discharge.

V. F. HANSON

(Electrochemicals department, E. I. Du Pont de Nemours and Company, Niagara Falls, N. Y.)

Terminal Corrections for Temperature Tests on Short Conductors

To the Editor:

We would like to make the following comments on the letter to the editor from Mr. W. N. Goodwin, Jr., "Terminal Corrections for Temperature Tests on Short Conductors," published in the January issue of *Electrical Engineering*, page 49.

Our main interest has been in temperature distribution along test samples for which the mid-point temperature rise is within one or two per cent of that which would occur with no terminal disturbance. Such conductors are usually short physically, but are correctly described by Mr. Goodwin as being long thermally. It is true that the long-line method is an approximation and that substantial errors occur when it is applied to sufficiently short conductors. We appreciate this clear-cut quantitative illustration, and hope that our previous letter (*EE, Nov. '42, p. 585*) did not seem to claim a too general validity.

In the calculation of thermally short conductors a practical difficulty appears which may not be obvious from reading Mr. Goodwin's paper, "The Compensated Thermocouple Ammeter," published in AIEE *Transactions*, volume 55, January section, pages 22–33, or from his letter. His equations cannot be directly applied to the interpretation of test data on thermally short conductors, for such data do not provide any direct means of measuring the over-all heat transfer coefficient, c, between the conductor and the surrounding medium. Therefore, the quantities θ_0, the temperature rise of the conductor if no heat were conducted away, and n, the thermal attenuation constant, cannot be evaluated.

This difficulty can be eliminated by evaluating θ_0 by the following method, applicable to a uniform conductor having equal temperature rises at the terminals, $T_1 = T_2 = T$. The linear heat conduction is then zero at the mid-point, and either half of the conductor can be treated as a short d-c line, open at the far end. Electrically, such a situation is expressed by

$$V_B = V_A \operatorname{sech} \alpha L \tag{1}$$

where V_A and V_B are the sending and receiving end voltages, respectively, and αL is the hyperbolic angle subtended by the whole line. The corresponding thermal quantities are V_A, the temperature disturbance at the terminals caused by the terminals, and V_B, the temperature disturbance at the mid-point caused by the terminals. Then $V_A = (T - \theta_0)$ and $V_B = (\theta_c - \theta_0)$. Substituting in (1):

$$(\theta_c - \theta_0) = (T - \theta_0) \operatorname{sech} nL/2$$

This can be rearranged to read:

$$\theta_0 = \theta_c \frac{\cosh nL/2 - T}{\cosh nL/2 - 1}$$

In this equation θ_0 is still implicit in the right-hand-side, since $n = (w/ak\theta_0)^{1/2}$. However, θ_0 can be found by using θ_c instead of θ_0 in the initial evaluations of n, and then using the method of successive approximations. The expression converges fairly rapidly, and for the example of the two-foot length of 3/0 wire already considered, three substitutions give a result for θ_0 that is two per cent from the correct one. In this particular case the terminals cause a 28 per cent disturbance $(\theta_0 - \theta_c)/\theta_0$ at the mid-point, whereas long-line computation indicates a disturbance of only seven per cent.

We wish to correct a proofreading slip in our previous letter (*EE, Nov. '42, p. 585*). The final paragraph should read ". . . If the temperature disturbance at the midpoint of a sample is to be limited to one per cent of that at the terminals, the minimum sample lengths range from about 4 feet for number 4 copper wire, to 12 feet for *750,000* circular mils conductor. . . ."

FREDERICK BAUER (A '42)
JEROME J. TAYLOR (A '40)
(Detroit (Mich.) Edison Company)

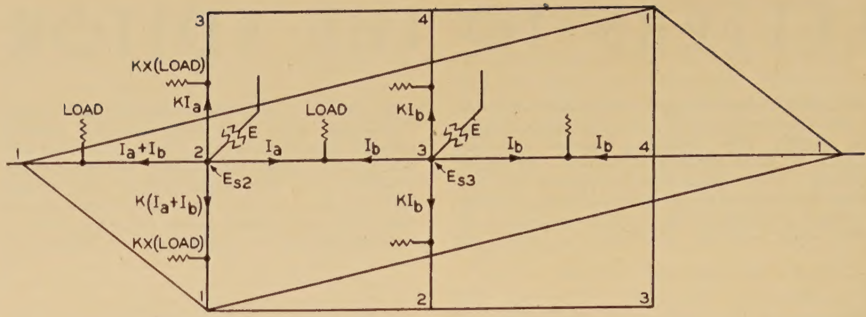


Figure 2. Case (b)—circuit 1 tripped out

Regulation and Load Division in Three-Phase Four-Wire Networks

To the Editor:

In the November 1941 issue of *Electrical Engineering* a letter to the editor written by the author on "An A-C Application of Hyperbolic Functions" appears on pages 563–4. Under conclusions it was stated: "The above method can be applied to a network with a concentrated load midway between blocks and also where the distance between blocks east and west is L and between blocks north and south in KL where K is any constant." The concentrated loads in north and south blocks likewise are assumed to be K times the concentrated loads in east and west blocks.

In this letter the author will present the theory for calculating current distribution and lowest voltage in a network with feeders staggered for case (*a*) no feeders tripped out; case (*b*) feeder 1 tripped out. The case for feeders not staggered is much simpler and therefore will be omitted. Finally a numerical example will be solved for cases (*a*) and (*b*). Nomenclature used is as follows:

E = voltage at primary of transformer referred to secondary side

E_s = nominal voltage at secondary side of transformer

L = length in feet between blocks, east and west

KL = length in feet between blocks, north and south (K is an integer)

y = load admittance of secondary per unit length

z = line impedance of secondary per unit length

I_n = normal transformer current before feeder 1 is tripped

Z_t = transformer impedance referred to secondary side

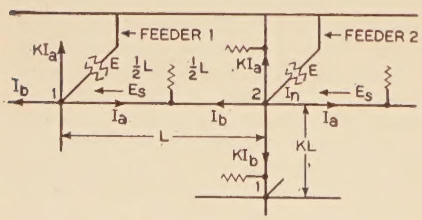


Figure 1. Case (a)—circuit 1 not tripped out

Figure 1 shows total load I_n on transformer 2 with distances between blocks L and KL.

$I_a = I_b;\ KI_a = KI_b$

$I_n = I_a + I_b + KI_a + KI_b$ (or if $K=1$)

$$I_n = 4I_a \quad (1)$$

Now

$$I_a = E_s yL/2 \text{ and } I_n = (E_s yL/2)2 + K(E_s yL/2)2 = E_s yL(K+1) \quad (2)$$

$$I_n = (E_s yL/2)4 = 2E_s yL \text{ (if } K=1) \text{ from equations 1 and 2} \quad (3)$$

$$E_s = E - I_n Z_t \text{ (or if } K=1) \quad (4)$$

$$E_{(\text{minimum})} = E_s - I_a zL/2 = E - I_n Z_t - I_a zL/2 \quad (5)$$

Figure 2 shows symmetry on both sides of feeder 3 and can be truly represented by Figure 3 where one half of transformer number 3 feeds to the left with an equivalent impedance of $2Z_t$, and with a current

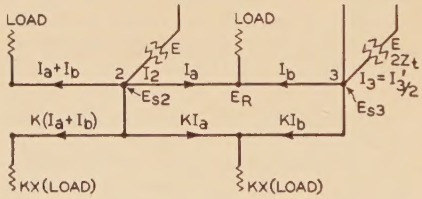


Figure 3

$I_3 = 1/2I_3'$ (I_3' = total current of transformer number 3).

As in case (*a*) (Figure 2)

$$I_a + I_b = E_{s3} yL \quad (6)$$

(I_a and I_b are not numerically the I_a and I_b of case (*a*) and

$$K(I_a + I_b) = K(E_{s3} yL)$$

Now

$$I_2 = (I_a + I_b) + K(I_a + I_b) + I_a + KI_a = E_{s2} yL(K+1) + I_a(K+1) \text{ (see Figure 3)} \quad (7)$$

$$\text{Again } I_3 = I_b + KI_b = I_b(K+1) \quad (8)$$

Since E is constant $I_2 Z_t + I_a(zL/2) = I_3 2Z_t + I_b(zL/2)$ (see Figure 3) (9)

Substituting I_2 of equation 7 and I_3 of equation 8 in equation 9

$$[E_{s2} yL(K+1) + I_a(K+1)]Z_t + I_a zL/2 = (K+1)I_b 2Z_t + I_b zL/2 \quad (10)$$

$$\text{or } I_a(K+1)Z_t + Z_t E_{s2} yL(K+1) + I_a zL/2 = I_b 2Z_t(K+1) + I_b zL/2 \quad (10a)$$

but $I_a = E_{s3} yL - I_b$ from (6). Substituting this value of I_a in (10a) and solving for I_b (assumed $E_{s3} = E_{s2} = E_s$)

$$I_b = E_s yL[(K+1)2z_t + zL/2]/3Z_t(K+1) + zL = E_s yL[4z_t + zL/2]/6z_t + zL \quad (11)$$

(when $K=1$)

but $I_b = E_s yL - I_a$ from equation 6. Substituting this value of I_a in (10a) and solving for I_a

$$I_a = E_s yL(K+1)Z_t + zL/2/3z_t(K+1) + zL = E_s yL(2Z_t + zL/2)/6z_t + zL \quad (12)$$

when $K=1$, from equations 7, 12, and 2

$$\frac{I_2}{I_n} = \frac{(K+1)4Z_t + 1.5zL}{3Z_t(K+1) + zL} = \frac{8Z_t + 1.5zL}{6z_t + zL} \text{ (when } K=1) \quad (13)$$

from equations 8, 11, and 2

$$\frac{I_3'\ (=2I_3)}{I_n} = \frac{(K+1)4Z_t + zL}{3Z_t(K+1) + zL} = \frac{8Z_t + zL}{6Z_t + zL} \text{ (when } K=1) \quad (14)$$

Assuming $E_{s2} = E_{s3} = E_s$ in above formulas greatly simplifies calculations and does not affect numerical results for I_2/I_n, I_3'/I_n', E_{s2}, and E_{s3} are accurately calculated later (see numerical problem).

Numerical problem:

L between blocks east and west = 250 feet

Network = 500,000-circular mil single conductor cable (approximately 4-inch spacing in duct)

Power factor = 0.9 lagging

Each transformer load = 450 kw (3-phase load)

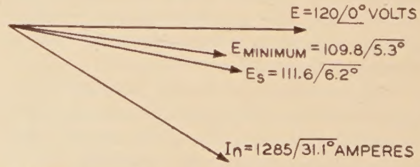


Figure 4. Vectorial values for case (a) using E as reference axis

E (referred to secondary) $=120$ volts to neutral $=120\lfloor 0$ (reference axis Figure 4)

Y (admittance of line) = negligible

z (per foot) $=0.0000627\lfloor 68.9^\circ$ ohms

$GE^2=$ watts $=450{,}000/3=150{,}000/$phase

$g=150{,}000/120\times 120=10.4$ mhos

g (each branch) $=10.4/4=2.6$ mhos

therefore $Y_{(\text{load})}=g/\cos\theta=2.6/0.9=2.88\lceil 25.8^\circ$ per 125 feet $=0.023\lceil 25.8^\circ$ per foot

$i_{(\text{transformer})}=1.5$ per cent $=0.015\times 120=1.8$ volts

$xi_{(\text{transformer})}=10$ per cent $=0.10\times 120=12$ volts

but

$I_n=150{,}000/0.9\times 120=1{,}380\lceil 25.8^\circ$ approximate amperes

therefore

$r_t=1.8/1{,}380=0.0013$ ohm

$x_t=12/1{,}380=0.0087$ ohm

and

$$z_t=\sqrt{(0.0013)^2+(0.0087)^2}=0.0088\lfloor 81.5^\circ \text{ ohms}$$

Case (a) circuit 1 not tripped out:

From equation 4

$E_s=E-I_nZ_t$

$E_s=120-(1{,}380)$ (approximately) $\lceil 25.8^\circ\times 0.0088\cdot\lfloor 81.5)=111.6\lceil 5.3^\circ$ volts

from equation 2

$I_n=E_syL(K+1)$

(if $K=1$)

$I_n=111.6\lceil 5.3\times 0.023\lceil 25.8^\circ\times 2\times 250=1{,}285\lceil 31.1^\circ$ amperes

$I_a=I_b=I_n/4=321\cdot\lceil 31.1^\circ$ amperes (from equation 1)

Comment:

In solving for E_s, I_n is unknown but an approximate value $1{,}380\lceil 25.8^\circ$ is used to get E_s; having obtained E_s an accurate $I_n=1{,}285\lceil 31.1^\circ$ is obtained and this I_n could be used to obtain a more accurate E_s.

$E_{(\text{minimum})}=E_s-I_azL/2$ (equation 5)

$E_{(\text{minimum})}=111.6\lceil 5.3^\circ-321.3\lceil 31.1^\circ\times(0.0000627\lfloor 68.9^\circ\times 125)$

$E_{(\text{minimum})}=111.6\lceil 5.3^\circ-2.52\lfloor 37.8^\circ=109.8\lceil 6.2$

$$\text{Per cent regulation}=\frac{120-109.8}{109.8}=\frac{10.2}{109.5}=9.3 \text{ per cent}$$

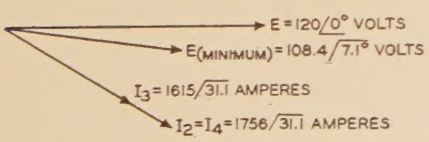


Figure 5. Vectorial values for case (b) using E as reference axis

Figure 4 shows these values vectorially, using E as the reference axis.

Case (b) circuit 1 tripped out:

From equation 13

$$\frac{I_2}{I_n}=\frac{8Z_t+1.5zL}{6Z_t+zL}=\frac{(8\times 0.0088\lfloor 81.5^\circ)+(1.5\times 0.0000627\lfloor 68.9^\circ\times 250)}{(6\times 0.0088\lfloor 81.5^\circ)+(0.0000627\lfloor 68.9^\circ\times 250)}$$

$$\frac{I_2}{I_n}=\frac{0.0936\lfloor 78.4^\circ}{0.0683\lfloor 78.4^\circ}=1.37=137 \text{ per cent;}$$

but $I_n=1{,}285\lceil 31.1^\circ$

therefore,

$I_2=1.37\times 1{,}285\lceil 31.1^\circ=1{,}756\lceil 31.1^\circ$ amperes

from equation 14

$$\frac{I_3'}{I_n}=\frac{8Z_t+zL}{6Z_t+zL}=\frac{(8\times 0.0088\lfloor 81.5^\circ)+(0.0000627\lfloor 68.9^\circ\times 250)}{(6\times 0.0088\lfloor 81.5^\circ)+(0.0000627\lfloor 68.9^\circ\times 250)}$$

$$\frac{I_3'}{I_n}=\frac{0.0859\lfloor 78.4^\circ}{0.0683\lfloor 78.4^\circ}=1.256=125.6 \text{ per cent;}$$

but $I_n=1{,}285\lceil 31.1^\circ$

Therefore

$I_3'=1.256\times 1{,}285\lceil 31.1^\circ=1{,}615\lceil 31.1^\circ$ amperes; $I_3=807\lceil 31.1^\circ$ amperes

$I_4=I_2$, by symmetry of Figure 2 $=1{,}758\lceil 31.1^\circ$ amperes

$I_1=0$ (circuit 1 tripped out)

$E_{s3}=E-I_32Z_t=120\lfloor 0-807\lceil 31.1^\circ\times 2\times 0.0088\lfloor 81.5^\circ=111.4\lceil 5.8^\circ$ volts

$E_{s2}=E-I_2Z_t=120\lfloor 0-1{,}765\lceil 31.1^\circ\times 0.0088\lfloor 81.5^\circ=110.6\lceil 6.2^\circ$ volts

From equation 12

$$I_a=\frac{E_{s2}yL(2Z_t+zL/2)}{6Z_t+zL}$$

$$I_a=\frac{110.6\lceil 6.2^\circ\times 0.023\lceil 25.8^\circ\times 250(2\times 0.0088\lfloor 81.5^\circ+0.0000627\lfloor 68.9^\circ\times 125)}{6\times 0.0088\lfloor 81.5^\circ+0.0000627\lfloor 68.9^\circ\times 250}$$

$$I_a=\frac{15.93\lfloor 47.8^\circ}{0.0683\lfloor 78.6}=238\lceil 30.8^\circ \text{ amperes}$$

$2(I_a+I_b)+2I_a=I_2=1{,}756$; $I_a+I_b=640$; $I_b=402$ (see Figure 2)

From equation 11

$$I_b=\frac{E_{s3}yL(4Z_t+zL/2)}{6Z_t+zL}$$

$$I_b=\frac{111.4\lceil 5.8^\circ\times 0.023\lceil 25.8^\circ\times 250(4\times 0.0088\lfloor 8.15^\circ+0.0000627\lfloor 68.9^\circ\times 125)}{6\times 0.0088\lfloor 81.5^\circ+0.0000627\lfloor 68.9^\circ\times 250}$$

$$I_b=\frac{27.3\lfloor 50.2^\circ}{0.0683\lfloor 78.6}=403\lceil 28.4^\circ \text{ amperes}$$

(see Figure 2)

(All the previously mentioned calculations were made with slide rule with no interpolating of tables.)

$E_{\text{minimum}}(=E_R$ Figure 3$)=E_{s3}-zL/2I_b=111.4\lceil 5.8^\circ-0.0000627\lfloor 68.9^\circ\times 125\times 403\lceil 28.4^\circ=108.4\lceil 7.8$

$E_{\text{minimum}}(=E_R$ Figure 3$)=E_{s2}-zL/2I_a=110.6\lceil 6.2-0.0000627\lfloor 68.9^\circ\times 125\times 238\lceil 30.8^\circ=108.4\lceil 7.1^\circ$

$$\text{Per cent regulation}=\frac{120-108.4}{108.4}=10.7 \text{ per cent}$$

Figure 5 shows these values vectorially, using E as the reference axis.

CONCLUSIONS

(a) Transformers 2 and 4 are overloaded 37 per cent when circuit 1 is tripped out. Transformer 3 is overloaded 26 per cent when circuit 1 is tripped out.

(b) Minimum voltage drops from 109.5 to 108.4 volts when circuit 1 is tripped out.

(c) Total current before circuit 1 is tripped $=4\times 1{,}285=5{,}140$ amperes. Total current after circuit 1 is tripped out $=0+1{,}756+1{,}615+1{,}756=5{,}127$ amperes.

Total load 5,140 amperes drops to 5,127 amperes due to reduced voltage.

	Before Tripping (See Figure 1)	After Tripping (See Figure 2)
I_1	1,285	0
I_2	1,285	1,756
I_3	1,285	1,615
I_4	1,285	1,756
I_a	321	238
I_b	321	403
I_a+I_b	642	640

I_a+I_b, 642 amperes drops to 640 amperes due to reduced voltage.

Therefore one can conclude (a) that circuit 1 may be accidentally tripped at full load without serious overload or voltage drop for a short time, and (b) circuit 1 can be tripped daily at the substation during periods of light load and in this way reduce transformer-iron losses about 25 per cent. Similar calculations can be made for other arrangements of staggered circuits and when K is not unity. Loads need not be proportional to L and to KL.

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Capacitance and Dissipation-Factor Correction

To the Editor:

In making measurements of capacitance and dissipation factor, it is sometimes necessary to make correction for the stray capacitance and leakage resistance of the instrument and leads. This correction, if worked out from fundamental considerations, is

lengthy and not adapted to slide-rule calculations. The following method was worked out when it was necessary to perform this calculation several times a day, and so far as known it has not been published. It assumes that the stray capacitance and leakage resistance can be regarded as a simple shunt across the unknown; also that the capacitance is measured in terms of the parallel network, or that it has been converted by the formula

$$C_{\text{parallel}}=\frac{C_{\text{series}}}{1+D^2}$$

Let the subscript T denote test values (C_T, D_T), the subscript o denote tare readings, and the subscript x denote the unknown. Then the capacitance can, of course, be corrected by simple subtraction: $C_x=C_T-C_o$. To correct the dissipation factor, compute the value of

$$D=\frac{C_o}{C_x}\,(D_o-D_T)$$

D is a correction which, when algebraically subtracted from D_T, gives the value of D_x. It will be noted that this formula is well suited to slide-rule calculations or to mental estimates. It does not involve approximations or simplifying assumptions.

The derivation is as follows:

Assume that $D_x=D_T-D$

Then $D=D_T-D_x$

Now, $D\times C=\frac{1}{\omega}G$

where G is the conductance

and $\omega=2\pi f$

and $G_x=G_T-G_o$

$$\text{Therefore } D=\frac{G_T}{\omega C_T}-\frac{G_x}{\omega C_x}=\frac{1}{\omega}\left\{\frac{G_T}{C_T}-\frac{G_x}{C_x}\right\}$$

$$=\frac{1}{\omega}\left\{\frac{G_T}{C_T}-\frac{G_T-G_o}{C_T-C_o}\right\}$$

$$=\frac{1}{\omega}\left\{\frac{G_TC_T-G_TC_o-G_TC_T+G_oC_T}{C_T(C_T-C_o)}\right\}$$

$$=\frac{1}{\omega(C_T-C_o)}\left\{\frac{G_oC_T-G_TC_o}{C_T}\right\}$$

$$=\frac{1}{\omega C_x}\left\{G_o-\frac{G_TC_o}{C_T}\right\}$$

$$=\frac{C_o}{\omega C_x}\left\{\frac{G_o}{C_o}-\frac{G_T}{C_T}\right\}$$

$$=\frac{C_o}{C_x}\left\{\frac{G_o}{\omega C_o}-\frac{G_T}{\omega C_T}\right\}$$

$$=\frac{C_o}{C_x}\left\{D_o-D_T\right\}$$

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NEW BOOKS • • •

The following new books are among those recently received from the publishers. Books designated ESL are available at the Engineering Societies Library; these and thousands of other technical books may be borrowed from the library by mail by AIEE members. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books. All inquiries relating to the purchase of any book reviewed in these columns should be addressed to the publisher of the book in question.

Patents and Industrial Progress. By George E. Folk. Harpers and Brothers, New York, N. Y., London, England, 1942. 387 pages, $8^1/_2$ by $5^3/_4$, $3.

The place of the patent in the industrial system of the United States is reviewed on the basis of material presented at the recent (1938 to 1941) hearings of the Temporary National Economic Committee. The testimony given before the committee is arranged to bring out the opposing cases presented by the Departments of Commerce and Justice. The separate reformatory recommendations and the final recommendations of the Committee are analyzed.

NAM Handbook on War Production. Compiled and Published by National Association of Manufacturers, Washington, D. C., New York, N. Y., San Francisco, Calif., August, 1942. 184 pages, charts, etc., $8^1/_2$ by 11 inches, paper, $1. (ESL).

This handbook for manufacturers is intended to bring together the information needed by those having war contracts or seeking them. How to go after a contract, how to sell to the Government, and the principles of cost determination under Government contracts are explained. The organization and functions of the War Production Board are described in detail, and the functions of the various agencies set forth. The priorities regulations are given in full, and there is a list of priorities orders, forms, and so forth.

Alternating-Current Machines. By A. F. Puchstein, T. C. Lloyd. 2d edition. John Wiley and Sons, Inc., New York, N. Y.; Chapman and Hall, London, England, 1942. 655 pages, illustrations, etc., $9^1/_2$ by 6 inches, cloth, $5.50. (ESL).

In dealing with the various types of a-c machines, each topic is treated approximately in the following order: construction; discussion of operating characteristics; calculation of operating characteristics from tests; discussions and analyses of various related phenomena. The revised edition has been brought up to date by the inclusion of new methods of analysis and recent standardization practices. As in the previous edition, only steady-state phenomena are covered with a few important exceptions.

The Vanderbilt Rubber Handbook. 8th edition. Edited by J. M. Ball. R. T. Vanderbilt Company, New York, N. Y., 1942. 464 pages, illustrations, etc., $8^1/_2$ by $5^1/_2$ inches, cloth, $5. (ESL).

This work beings together a large amount of technical information on rubber, especially on compounding for various purposes and on testing methods. Both dry rubber and latex are discussed.

PAMPHLETS • • •

The following recently issued pamphlets may be of interest to readers of "Electrical Engineering." All inquiries should be addressed to the issuers.

The Technical Book Publisher in Wartimes. By James S. Thompson. The New York Public Library, New York, N. Y., 1942. 24 pages, no charge.

Engineering in Our Early History. By Dugal C. Jackson. Reprinted from the Proceedings of the American Philosophical Society (volume 86, number 1), Lancaster, Pa., 1942. 51 pages.

Electric Power in Wartime. By Calman Winegarden. Bureau of Labor Statistics, United States Department of Labor, Washington, D. C., 1942. 17 pages.

Lesson of the Last World War. By James T. Shotwell. American Institute of Consulting Engineers, New York, N. Y., 1942. 46 pages.

How Management Can Integrate Negroes in War Industries. By John A. Davis. New York State War Council, 1942. 43 pages.

Boiler-House Measurement and Control for Efficient Fuel Utilization. By G. H. Barker, A. L. Hancock. The Institution of Electrical Engineers, London, England, 1942. 11 pages.

The Application of Electricity in Mine Pumping. By G. B. Alvey, N. Tetlow. The Institution of Electrical Engineers, London, England, 1942. 17 pages.

Controlled Materials Plan. War Production Board, Washington, D. C., December 21, 1942. 30 pages.

Handbook of Industrial Safety Standards, National Conservation Bureau, New York, N. Y., revised 1942. 190 pages. Single copy 55 cents (paper), 75 cents (leatherette); quantity prices furnished on request.

War Housing Manual. Construction Bureau, War Production Board, Washington, D. C., 1942. 38 pages.

The Total and Free Energies of Formation of the Oxides of Thirty-Two Metals. By Maurice de Kay Thompson. The Electrochemical Society, Inc., New York, N. Y., 1942. 89 pages, $1.

War Production in 1942. War Production Board, Washington, D. C., 1942. 21 pages.

Fire Bomb Fact Sheet. Office of Civilian Defense, Washington, D. C., 1942. 4 pages.